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A DEEPER ENTRANCE TO NEW YORK HARBOR is recommended by Col. G. L. Gillespie, Engineer Corps, U. S. A., in a late report to the Secretary of War, upon the need and cost of a 35 ft. channel at low-water. There has been since 1891 a continuous waterway, from the Narrows to the Atlantic, 1,000 ft. wide and 30 ft. deep at mean low water, as provided for in the River and Harbor Act of 1884. But the average draft and tonnage of steamers coming to this port have progressively increased within the last six years; and the average draft of outgoing loaded steamers is now 27 ft. The draft of some of the larger vessels has reached 30½ ft. on their outward passage. As these vessels should have 2 to 3 ft. of water under their keels, a depth of 35 ft. is urgently needed, and the improved channel should be wider than 1,000 ft., owing to the increased length of steamers. The estimated cost for deepening and enlarging the channel to widths of 1,000; 1,500 and 2,000 ft. is given as $1,740,000, $2,772,000 and $4,180,000 respectively, all to be 35 ft. deep at mean low water.

THE EADS CHANNEL, through the South Pass of the Mississippi River, is threatened by the existing crevasse in Pass a l'Outre, and Senator Caffery, of Louisiana, is seeking an appropriation of $250,000 for repairs at this point, and practically asks that this sum be deducted from the $500,000 due to the heirs of James B. Eads, in 1900. The heirs vigorously protest against this proposition; they say it is no part of their duty to close this break, although they have actually expended $200,000 in a vain attempt to do so. They affirm their entire ability to maintain a deep channel in the South Pass until 1900, and then their responsibility ends. A syndicate is said to be already formed in New Orleans to deepen the South West Pass by jetties; and a similar syndicate will probably be formed to care for the South Pass Channel after 1900, in the mercantile and maritime interests of the people of the southwest. Meanwhile Congress is asked to repair the damage which originally started by oystermen, in digging a harbor in Pass a l'Outre for their boats.

THE BROOKLYN DRY DOCK NO. 3 is practically completed; the pumping plant is in position and has been satisfactorily tested and it is expected that the dock itself will be officially tested by the "Puritan" on Feb. 15. In regard to recent newspaper rumors charging a lack of observance of the specifications by the contractor who built this dock, it is now stated that the dock is 22 ins. shorter than the 670 ft. originally contemplated. But this shortening is the legitimate result of a modification of the older plan, which resulted in making the whole dock 12 ins. deeper, instead of 4 ins. shallower, as was reported. Some bulging in the side of the dock is reported by Civil Engineer Menocal as being due to lack of proper drainage in the ground near the dock. This can be remedied by proper grading.

THE CONGO RAILWAY, says London "Engineering," reported progress as follows, to June, 1896: Proposed length of line, about 250 miles; rails laid on 121¼ miles, with grading completed for 131¼ miles; expended on the construction and equipment of the 122 miles finished, including interest on capital, $7,704,065, or over $63,000 per mile. The rolling-stock owned includes 24 locomotives, 4 tenders, 40 first class and 1 second class passenger carriages, and 105 trucks of various kinds. The revenue from the line opened is gradually increasing. In July, 1896, for example, the gross receipts were $36,350, as compared with $14,130 in July, 1895. Though constructive operations are reported as becoming easier, the estimated cost of the completed line is placed at about $15,000,000.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision on the Buffalo, Rochester & Pittsburg Ry., near Leroy, N. Y., Jan. 28. A freight train ran into a snow plow which was being pushed to a siding to get out of the way of the freight train. The conductor and a brakeman on the plow were hurt. Both engines were wrecked and several cars derailed.——A serious collision occurred Jan. 29 on the Lexington Ave. line of the Brooklyn Elevated R. R., Brooklyn, N. Y. The line has three tracks east of Van Sicklen Ave. station, the middle track being used for storing cars, and ending west of the station by two turnouts connecting with the main tracks. The three switches are not interlocked. As an eastbound train was approaching the station a train of empty cars was coming down the middle track, and owing to a misplaced switch this train ran down to the eastbound track. The engine of the empty train struck the other at the side of the smokebox, and knocked it clear off the tracks into the street. The front end of the first car also went over the structure and rested on the street. One man was killed and five or six were injured. No damage was done to the structure beyond the breaking of some ties and guard timbers. The floor was of the usual type, with double guard timbers to each rail, these guards being necessarily partly omitted at the switch. The engine of the empty train had just been run from the eastbound track to the middle track, and the switchman had gone to help couple up the cars to this engine, leaving another switchman to close the switch, which he failed to do. There seems to have been no very clear instructions as to the duties of the three switchmen implicated. The coroner's jury laid the responsibility on the engineman of the empty train for not having noticed that the switchlight indicated that the switch was open for the wrong track, and censured the fireman for not having noticed the switchlights, as the engine was running backwards and he should, therefore, have been on the lookout, the engineman's view being obstructed. The three switchmen were also censured. We believe this is the first accident of its kind, although some accidents have happened in which engines or cars have run through the bumpers and fallen off the end of the structure of an elevated railway.

A COLLISION ON THE BROOKLYN BRIDGE cable railway occurred Jan. 29 between two empty trains which were being switched at the New York station. One train was moving from the stub or tail-switching track to the outgoing track, when another train, which had just discharged its passengers, was started too soon to run from the incoming track to the stub track. It struck one car of the first train at the switch, knocking that car over on its side. Both trains were being operated by electric motors on the cars. We learn on inquiry that the switchman in the switch tower saw that there was danger of a collision, and called to the motorman of the second train to stop his train. The motorman evidently also saw the danger, but got confused, and instead of shutting off the current he moved his controller handle in the wrong direction, thus increasing the speed of the train. He had at hand a reversing lever which, if used, would have stopped the train in about 10 ft., but this the man failed to use. The motorman had been employed on railways for 27 years, had been put through the motor school on the bridge, and had also passed a rigid written examination on the book of instructions. He, however, "lost his head" in the emergency, and as this showed him to be unsuited for the work, he was discharged as soon as an investigation had been made.

A FREIGHT ELEVATOR used in hoisting men and building materials at the new building for the New York Life Insurance Co., 346 Broadway, New York, fell Feb. 2, dropping seven stories. There were six men on the car, but none were injured, as they clung to the beam across the top of the cage and were only hurt by the shock causing them to let go when the cage struck the cellar floor.

CABLE CAR ACCIDENTS on the curve at Broadway and 14th St., New York city, have become so numerous that the railway company has been indicted for maintaining a nuisance. The cars are run at full speed round this curve, owing, it is claimed, to the impossibility of picking up the cable if dropped on the curve, and pedestrians and vehicles are frequently struck by the cars. A special slow-speed cable between 14th and 17th Sts. has been suggested as a remedy.

A TRAIN WRECKER has been convicted at Birmingham, Ala. A negro named Fagan, the alleged leader of a gang of negro miners who formed a conspiracy to wreck trains, and threw the Washington express of the Southern Ry. off the track on McComb trestle, 90 ft. high, near Birmingham, Ala., on Dec. 22, was found guilty Jan. 31. The penalty is ten years in the penitentiary, but it is said that the present legislature will probably make it death. Fagan's accomplices are yet to-be tried.

THE SMOKE NUISANCE is now being considered by the Commissioners of the District of Columbia, who are preparing a bill to be introduced in Congress providing for the punishment by fine of any owner of a steam boiler or locomotive engine which emits dense smoke, and for the appointment of a smoke inspector under the Health Department, whose duty it is to see that the law is complied with.

AN EXTENSION OF CHICAGO'S WATER-SUPPLY tunnels in addition to a system of intercepting sewers will, it is stated, be recommended by the expert commission appointed to devise ways and means of protecting the city's water supply from sewage pollution. Briefly stated it is proposed to lay 9-ft. pipe lines from the present intake cribs out into the lake, similar to the 5-ft. pipe line built at Milwaukee, Wis., in 1895 (Eng. News, Sept. 19, 1895). This pipe line construction will place the intakes considerably further from the sewage polluted shore than they are at present, but in addition it is proposed to prevent the entrance of sewage into the lake by building two intercepting sewers; one 11 ft. in diameter which will take the sewage now entering the lake north of the Chicago River, and one 13 ft. in diameter, which will serve the same purpose on the south side of the river. The intention is, of course, to connect these two sewers with the Chicago Drainage Canal. Besides the new sewers the plans, it is stated, call for considerable modifications and change in the city's present sewerage system. It is estimated that the work will cost about $3,000,000. The commissioners are Mr. G. H. Benzenberg, M. Am. Soc. C. E., City Engineer Milwaukee, Wis.; Mr. Lyman E. Cooley, Consulting Engineer, Chicago, and Mr. Joseph Downey, Commissioner of Public Works, Chicago.

THE CONTRACT FOR A TRIPLE EXPANSION pumping engine of 30,000,000 gallons capacity for the Chestnut Hill station of the Metropolitan Water Board of Boston, Mass., has been awarded to the Edward P. Allis Co., of Milwaukee, Wis. The duty guaranteed is 150,000,000 foot pounds duty, which is the highest ever named. It is to be located in the same building with the famous Leavitt triple expansion engine and will be supplied with steam at the same pressure, 185 lbs. It will weigh about 800 tons, and is expected to be in operation in about 18 months.

THE INCREASED TAX LEVY FOR THE CHICAGO Drainage Canal, together with other supplementary legislation asked of the Illinois State Legislature by the Trustees of the Sanitary District of Chicago, as noted in Engineering News, Jan. 7, 1897, seems likely to meet considerable opposition. At a recent meeting of the Real Estate Board of Chicago resolutions were passed unanimously opposing the increase of tax asked as unnecessary. Following this action the legislators from the various Illinois River Valley towns have signified their intention of demanding a full accounting of the Sanitary District's financial affairs before allowing the proposed legislation to be enacted.

EXTENSIONS TO THE NIAGARA FALLS POWER plant have been approved by the directors of the Cataract Construction Co. According to published accounts, an extension of the power house is to be built over the new pit, and contracts will be made with the I. P. Morris Co., of Philadelphia, for five 5,000-HP. turbines, and with the Westinghouse Electric Mfg. Co., of Pittsburg, for five 5,000-HP. dynamos. Contracts for five governors for the new turbines and for five new sluice gates will be awarded to William Sellers & Co., of Philadelphia. Both turbines and dynamos are to be identical with those already installed. The new contracts will probably all be awarded from the New York office. An agreement is also said to have been signed by which the Acetylene Heat, Light & Power Co. becomes the largest consumer of electric power generated by the Cataract Construction Co. The latter has contracted to furnish 4,000-HP. additional to the Acetylene company in installments during the year. It is furthermore expected that before the close of 1897 all of the street railway lines in the city of Buffalo will be operated by electric power supplied from Niagara Falls.

THE LONGEST BRIDGE IN THE WORLD, according to the "Zeitschrift fuer Transportwesen und Strassenbau," is a stone structure, which near the city of Sangang in China spans an inlet of the Yellow Sea. Its length as claimed is 8¼ kilometers, (5¼ miles.) The number of piers in the structure is 300; each of those is ornamented with a marble lion executed in three times life size. The top of the roadway is located 64 ft. above mean low water level. The bridge, as claimed, is about 800 years old, and its masonry is reported to be in an excellent state of preservation. The highway bridge across West Galveston Bay, at Galveston, Tex., (Eng. News, March 8, 1894) is 11,309 ft. long, of which 7,432 ft. are composed of metal spans, and 3,877 ft. are of pile trestle work.

NEW FREIGHT STATION AT COLUMBUS, O., FOR THE PITTSBURG, CINCINNATI, CHICAGO & ST. LOUIS RY.

(With two-page engraving.)

The freight station which we illustrate herewith was recently built at Columbus, O., by the Pittsburg, Cincinnati, Chicago & St. Louis Ry. The general plan of the station is shown in Fig. 1, and from this it will be seen that there are two freight houses, 148 ft. apart, with six single stub tracks and seven platforms in the space between them. The track spaces are 11 ft. wide; the three middle platforms are 16 ft. wide; the next two are 11 ft. wide, and the two end platforms (along the sides of the freight houses) are 6 ft. wide. There is also an end platform connecting the longitudinal platforms. The platforms are all 3 ft. 9 ins. above the level of the heads of the rails, and are all covered by shed roofs, supported by center posts. The freight houses are 632 ft. long. One of these is the receiving freight house, 60 ft. wide, and the other is the delivery freight house, 29 ft. wide. At the inner end of the station is a brick headhouse for freight offices, 35 × 140 ft., and also a building 25 × 29 ft. for the yardmaster's office. The receiving freight house has four weighing scales 160 ft. apart, and the delivery freight house has six weighing scales 96 ft. apart, and also a cold-storage room at the outer end. The end of the station toward the yards is shut in by iron

FIG 2.—VIEW OF FREIGHT STATION, SHOWING OFFICE BUILDING AND RECEIVING FREIGHT HOUSE.

fences at the ends of the platforms and gates across the tracks. The freight houses are of frame construction, with 16-ft. panels. The sheathing is of corrugated iron, and the doors are also of iron. On the track side the doorways are in alternate panels, while on the street side there is a doorway in each panel. A general view of the station, showing the offices, buildings and the street front of the receiving freight house, is given in Fig. 2, while Fig. 3 is an elevation at the north or outer end of the station, showing the platforms and platform shelters and the iron enclosing fence.

In using the station the central platform will be chiefly devoted to the transhipment of through freight which requires transfer from one car to another, on account of its destination or in order to make up full carloads. Cars with freight consigned to Columbus will be run in on the track next the delivery freight house, while cars to take outgoing freight will use the tracks next the receiving freight house.

The details of the construction of the receiving freight house and the yard platforms are shown in Figs. 4 and 5. The foundations are of masonry, and the floor is of planking laid on sleepers 4 × 6 ins., embedded in a 10-in. bed of cinders, which rests on an earth filling. The 6-ft. platforms along the track side of this house are supported by 18-in. brick walls. The building has a clear headway of 18 ft. to the bottom chords of the roof trusses, and these trusses are 12 ft. deep at the center. Diagonal corner braces connect the trusses with the posts, and are bolted to both chords of the trusses, as well as to the posts. These provide for resistance to lateral pressure and wind strains.

The delivery freight house, Fig. 6, is of generally similar construction, but is only 29 ft. wide. These freight houses are provided with arc lamps, and rows of two-light gas pipes.

The general arrangement of the freight office building is shown in the plan, Fig. 1, and Fig. 7 shows the east end elevation and a partial cross section.

One of the interesting features of the freight houses is the style of door used for the numerous doorways. These doorways are 12 ft. wide and 8 ft. 6 ins. high. The doors are rolling steel shutters, 12 × 12½ ft., composed of horizontal steel slats 2 ins. wide, which interlock with one another from end to end. The door is re-enforced at the bottom by vertical iron bars (inside and outside) 12 ins. apart; an angle iron extends the whole length at the top, and a tee iron at the bottom. This re-enforcement is put on for two purposes: 1, in case of barrels or boxes rolling down the incline of the floor on the inside of the building; 2, in case of wagons backing against the door from the outside, though this is not likely to occur. In case of an accident by which any of the slats are damaged, the defective ones can be slipped out and new ones substituted. This is done by removing one side of the guide groove, allowing the curtain to be removed several inches; the old slats are then taken out and the new ones substituted. The door is counterbalanced by a hanging equilizing weight, which is attached to a chain that runs over a sprocket wheel on a 3-in. gas pipe, to which the steel door is attached. For raising and lowering there is a 15-in. sprocket wheel on the end of the shaft, from which hangs a continuous chain. For locking the doors one link of the lifting chain is slipped over an iron hook on the inside, which makes a positive instantaneous fastener. These doors are shown in Figs. 8 and 9. They were built by the Kinnear & Gager Co., of Columbus, O., to whom we are indebted for blue prints of the doors and the photographs which we have reproduced in Figs. 2 and 10.

The station was built by the Pittsburg, Cincinnati, Chicago & St. Louis Ry., from plans prepared under direction of Mr. Thomas H. Johnson, M. Am. Soc. C. E., Chief Engineer. To his courtesy we are indebted for the information and blue prints used in the preparation of this article.

FIG. 9.—VIEW OF ROLLING DOORS AND WAGON PLATFORM.

A BOLT AND NUT WORKS OPERATED BY ELECTRIC POWER.

The new nut and bolt works of Plumb, Burdict & Bernard, at North Tonawanda, N. Y., the largest works of the kind in the country, has been waiting, fully equipped, for receiving electric current from Niagara Falls, for the past year. When the electrical equipment was under consideration, the three-phase system was selected instead of the two-phase, since the three-phase system, having been chosen by the Niagara Falls Power Co., for the transmission of power from Niagara Falls to Tonawanda and Buffalo, the bolt and nut works can be operated directly from the transmission line by simply connecting the necessary static transformers.

The factory is situated at North Tonawanda, on the lines of both the New York Central and the Erie railways, and about half a mile from the overhead wires of the Niagara-Buffalo transmission. It is divided into three single-story brick shops.

Until Niagara power can be obtained, the works are being operated from their own generating station, which will be abandoned as soon as the Niagara Power Co. is ready to tap the three-phase lines into the factory. Steam is supplied by three return tubular boilers, each of 100-HP. A 400-HP. Greene engine is belted to a General Electric Co.'s three-phase six-pole 150-K-W, 25-cycle, 500-R. P. H. generator. The exciter is a 3-K-W, 125-volt bipolar machine.

The forge shop is a building about 360 ft. long and contains five 20-HP. General Electric induction motors, four driving the shafting and one operating a blower. The shafting is divided into four sections, and each one is belted to one of the induction motors. The driving motors are set upon a platform above the shafting in the center of the shop, and are boxed in. The blower motor, directly connected to the blower, occupies a platform at the south end of the shop. The machines driven by the motors in the forge shop are different sizes of bolt headers and nut punchers and shearing machines for shearing the bolt lengths from the rod.

In the cold shop, the pointing department is operated by one 20-HP. motor, set on the floor and belted to jack-shafts and counter-shafts.

In the machine shop, on the south side of the engine room, is another 20-HP. motor, also set upon the floor. It is used to drive a variety of tool-making machinery, such as planers, milling machines, drills, slotters, shapers, etc.

The threading and finishing shop, 400 ft. long, is next in length to the cold shop, which is 430 ft. in length. In it the bolts and nuts, traveling from the other shops, are threaded and tapped and put together ready for the market.

This shop is driven by six 6-HP. motors set on small platforms, and three 20-HP. motors. The smaller motors and one 20-HP. motor are used to drive the automatic and semi-automatic machines. For the former they are belted to jack-shafts from which belts are dropped to pulleys on a shaft running underneath the machinery. For the semi-automatic machinery, the pulley is on the level of the machines and is belted to the jack-shaft above.

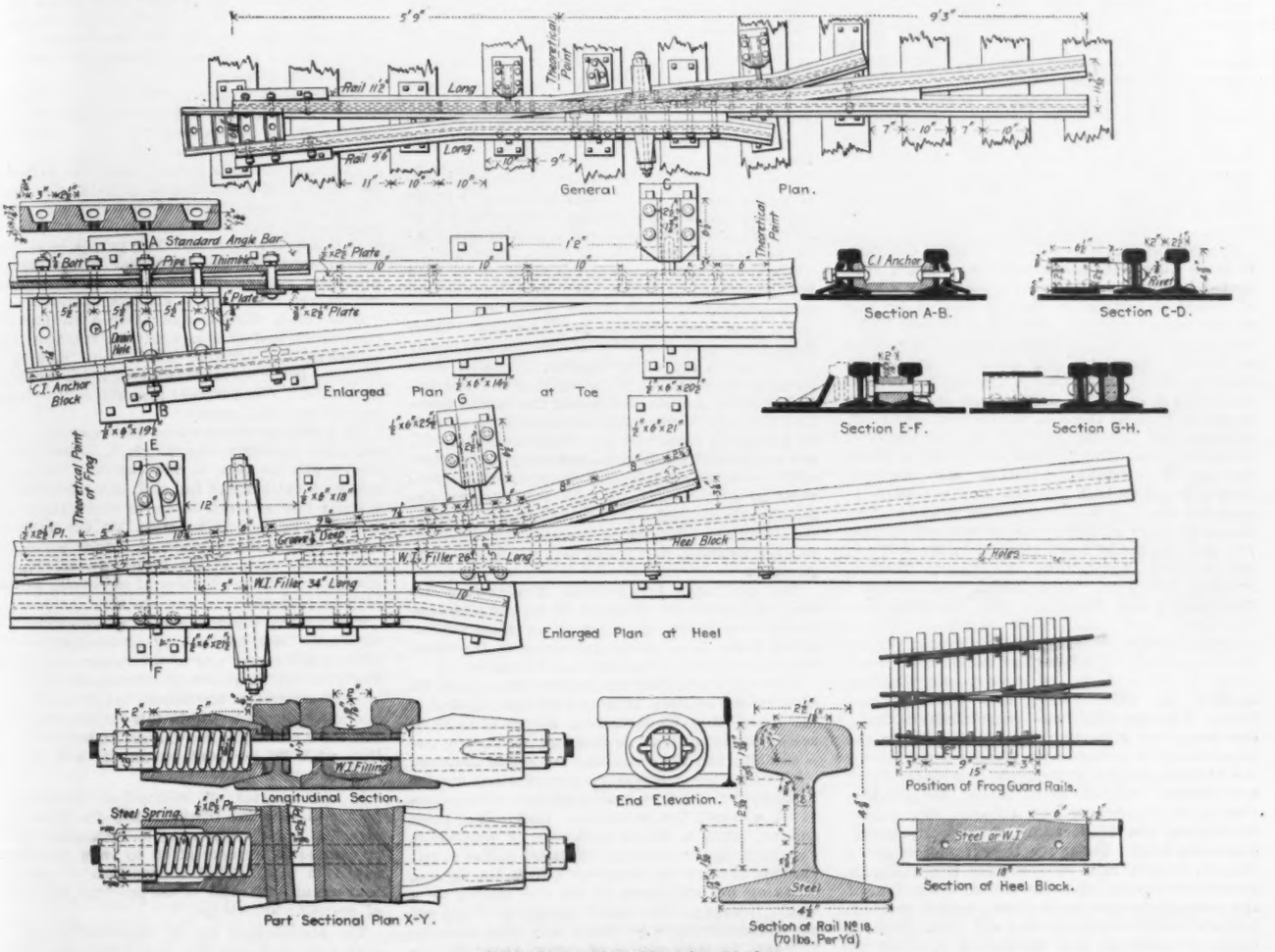
The other 20-HP. motors are set on the floor and

are belted to shafting on the opposite sides of the shop, which drives the heavy threading and tapping machines, which are not automatic. The sizes of bolts made run from 3-16-in. up to 1½-in.

The advantages of electric driving are well shown by this plant. There are no separate engines for the individual shops, and no belt holes in the walls as would have been the case had the steam driving plant been confined to an outside building. The motors in the forge shop occupy no space on the floor of the shop, and those in the other shops occupy either small space upon the floor or are erected on small platforms. They require no attention beyond the filling of oil wells, which is performed but once in six months. They are started by the mere throwing of a switch, and maintain a steady speed under all conditions of load.

SPRING RAIL FROG; UNION PACIFIC RY.

In the notes on the Union Pacific Ry. in our issue of Sept. 17, 1896, reference was made to an improved form of spring rail frog, designed by Mr. Geo. H. Pegram, M. Am. Soc. C. E., Chief Engineer of the Union Pacific Ry., and this frog we illustrate herewith.



SPRING RAIL FROG; UNION PACIFIC RY.
Geo. H. Pegram, M. Am. Soc. C. E., Chief Engineer.

The special object in view in designing this frog was to increase the safety in the use of the frog and to provide ample strength at the points where it is most needed, while at the same time avoiding an undue increase in the weight, since such increase of weight beyond actual requirements not only causes an increase in cost but is also very likely to interfere with the proper and easy working of the movable parts. The main features of this frog are that the spring rail is reinforced for its entire length, so that there is no place at which it can break and come apart. It is also grooved to allow the passage of false flanges on the wheels, and is provided with lugs to prevent any overturning tendency. In fact, the aim has been to prevent the possibility of accident through the recognized dangers which are incident to spring rail frogs.

The cut shows a No. 10 frog, 15 ft. long, made from 70-lb. rails, the point being 5 ft. 9 ins. from the throat end and 9 ft. 3 ins. from the heel end. The spring rail is reinforced by two refined iron bars ½×2½ ins. and ⅜×2½ ins., riveted to the web of the rail. The spring is of ⅜-in. coiled steel, placed a little distance back from the frog point, and the free end of the spring rail is guided in its movement by an arm formed by bending the reinforcing bar (as shown), this arm working in a guide sleeve. A similar arm and sleeve are placed ahead of the frog point. The frog point has five ¾-in. rivets, and a wrought-iron filler 34 ins. long is placed between the point and the fixed wing rail, this filler extending beyond the frog point. The frog point and fixed wing rail are held together by five 1-in. bolts passing through the filler. The fixed parts are riveted to ½-in. steel plates by ¾-in. rivets. To allow for the easy passage of false flanges on the wheels there is a steel or wrought iron raising block at the heel, and the spring rail is grooved out to a depth of ¼-in. so that it will not be struck and forced out by wheels having false flanges. The guides on plates Nos. 3 and 7, and the lug on plate No. 4 prevent any overturning of the rail or any undue widening of the flangeway. At the mouth of the frog is a heavy cast-iron anchor block.

On the cut is shown the position of the frog guard rails, which are 15 ft. long, having 7 ft. 6 ins. of their length in front of and behind the frog point. These guard rails are straight for 9 ft., giving a flangeway of 2 ins., and have each end flared out for 3 ft. to an end spacing of 5 ins. The rails are spiked to every tie and reinforced by five rail braces to each rail.

NOTES FROM THE ENGINEERING SCHOOLS.

Technical Education in New South Wales.

"Where is the best system of technical education to be found?" is a question which is apt to be asked by an individual who wishes to endow a new technical school, by a public body which desires to add technical education to its existing school system, or by the authorities of existing schools who wish to improve them. "Here in the United States" would probably be the answer of most of those who have compared the schools of America and Europe, but we are not certain that "in New South Wales" would not be a more correct reply. At least we have formed some such impression as the result of the perusal of a pamphlet of 113 pages issued by the Department of Public Instruction of New South Wales, and entitled "Calendar, 1896, Giving Details of the Course of Instruction for Each Class in the Sydney Technical College and Branch Schools, and Particulars as to the Technological Museums." It is rather poorly printed government publication, apparently compiled without intelligent editing, and we have not been able to find in it such information as, how old is the technical college, how many students it has as a whole or in any department, and what are the fees; but enough is given in it to show that the Department of Public Instruction in New South Wales is probably farther advanced in its ideas of what facilities for technical education should be provided by the government, and of

how a technical college should be conducted than the educational department of any other government in the world, or that of any state in the United States. In this country technical education under government auspices has scarcely gone further than the partial endowment, under the Morrill Land Grant Act of 1862, of the State Colleges of Agriculture and the Mechanic Arts, and the individual states have supplemented these endowments to a greater or less extent. Many cities now supply elementary manual training as a part of the grammar or high school instruction. With these exceptions nearly all the growth of technical education in this country has been due to private munificence. We have as a result a splendid set of engineering schools, in many of which the course of instruction in certain lines is equal, if not superior, to that found anywhere else in the world, but they are formed on different plans, and most of them are very narrow in scope. The technical schools of this country are divided into three main divisions. (1) Manual training schools, such as are attached to our grammar and high schools, which give fundamental instruction in wood and iron working, drawing and the production of art forms. (2) Professional technical schools, which are almost exclusively schools of engineering, architecture or chemistry. (3) Trade schools, in which the elements of the mechanical trades are taught, and sufficient practical instruction is given to enable the graduates to take the position of journeymen. Of this class there are only a few examples, such as the New York Trade School and the Williamson School, near Philadelphia, both of which are privately endowed.

The New South Wales idea is entirely different. It is to have one grand technical college, supported by the government, in which any course of technical instruction that is desired by any student may be found. There is a manual training department in the college, besides a number of branch manual training schools in connection with the city public schools. There are several departments in which professional courses may be taken, such as those in mechanical, electrical, sanitary and mining engineering, architecture, chemistry, etc., and besides there are a great number of other departments and separate classes in which both scientific and practical instruction relating to special trades is given. The names of some of these departments and classes will give an idea of how extensive is the scope of the college: Agriculture, Veterinary Science, Farriery, Sheep and Wool, Coal Mining, Sanitary Engineering and Plumbing, Art, Industrial and Decorative Art, Household Economy, Lithography, Dress Cutting and Dress Making. Under the Department of Mechanical Engineering are a Drawing Office Course of three years; Pattern-Making, one year; Fitting and Turning, two years; Blacksmithing, one year; Boiler-Making, one year; Iron Founding, two years. Under the Department of Architecture there are classes for the Building Trades, in Masonry, two years; Stone and Marble Carving, three years; Bricklaying, two years; Carpentry and Joining, two years; Staircasing and Handrailing, for advanced students, one year. Under the Department of Art a class in Pottery is to be organized if a sufficient number of students apply, in which will be taught the manufacture of terra cotta, model making, potter's wheel work, turning, etc. The Department of Industrial and Decorative Art will include among other classes one in Housepainting (elementary) two years, and one in Graining and Marbling, two years. A three years' course in general and sanitary pumbing is given in the Department of Sanitary Engineering. The following extract from the "Syllabus," of the Department of Training in Sheep and Wool, will give an idea of the lines on which the institution is working:

> The mode of training is framed to fit each student to undertake the classification, skirting, rolling of fleeces, and sorting the skirts or pieces to the best advantage of the grower, and also to meet the demands of the buyers. As the practical work advances, lectures upon all subjects relating to the growing of wool and its suitability for manufacturing purposes will be given. The Sydney wool sales afford all facilities for gaining information of the general routine of the business, special attention being given to valuating.
>
> Lectures will be given upon sheep and wool at the country shows, and, as many of the shows take place after July, a great deal of good should be done to our staple industry. It is a well-known fact that the greater part of the colonial wools are placed upon the market in a very indifferent manner, and if subjects relating to wool could be discussed at these shows, it would be of great benefit to the grower and the public generally. There are about 52,000,000 of sheep in New South Wales, and it is considered by the highest authorities that if information such as proposed in these lectures were given, a general improvement in the flocks would result, and as it is computed that every sheep would produce 1s. worth more wool, the total annual gain to the Colony would be £2,600,000.

Massachusetts Institute of Technology.

The occupation of graduates, as published in the annual catalogues of the Institute, furnish testimony as to the value of the work of this school in fitting its students for the various scientific professions. The classes of the five years, '91 to '95 inclusive, may be taken as fairly illustrative of the Institute work at the present time. The occupations of the last graduating class are omitted as being less permanent. The statistics of the five classes considered show as far as possible the present occupation of nearly 640 graduates. The greatest number from one course is that of the Electrical Engineers, 162, although at the present time the number of students taking Mechanical Engineering is slightly larger than the number studying Electrical Engineering. The graduates of this course are engaged for the most part in electrical work, nearly one-fourth of them holding positions in various telephone and telegraph companies. About 7% are engaged in engineering work other than electrical; about 6% are teaching; and about 11% are engaged in mercantile pursuits.

The Mechanical Engineers are next in number in this list. Of the 141 graduates, over two-thirds are occupied as Mechanical Engineers; 16, or about 11%, are teaching; while a little less than 8% are in business.

The Civil Engineers hold the third place, with 107 graduates, of which over 80 are practicing their profession, while 6 are doing educational work, 3 of them holding professorships. These three courses, it is worthy of note, include nearly two-thirds of the whole number, the other third being divided among the remaining ten courses. Of these the courses graduating the largest numbers are the Chemical and the Architectural, with 48 graduates each. Of the Architects, over 10% are teaching; six graduates are studying in Paris, while over two-thirds are doing Architectural work as a profession. A somewhat similar distribution is seen among the graduates in Chemistry. Six are studying in German Universities; five are teaching, and nearly 70% are in Chemical pursuits.

The graduates in Chemical Engineering are next in number, 41, of whom 31 appear to be engaged in Chemical Engineering, or allied professional work; 2 are patent examiners at Washington; while 3 are inspectors for insurance.

In the course in Sanitary Engineering, one of the most recent courses, 14 graduates are enrolled in the years '92 to '95, inclusive. Eleven of these 14 are employed as Civil or Sanitary Engineers, one is teaching and the remaining two are in business.

In the course of Naval Architecture and Marine Engineering, the first graduates were of the class of '95, and only five in number. Only one of these can be called a Naval Architect by profession, yet the meagreness of the statistics makes it impossible to draw any conclusion from the figures.

Taking the graduates of the five classes as a whole, it appears that about two-thirds of the 640 are engaged in work for which they were specially prepared by their course of study; about 6% are engaged in allied professional work; about 9% have become teachers; about 2% have not reported, while the remainder are engaged in mercantile pursuits.

In the Course in Electrical Engineering the series of lectures on Electro-metallurgy, given to students of Electricity for the first time last year, has now been adopted as an integral part of the course. These lectures, given by Professor Hofman, of the Mining Department, treat of Electricity as applied to the extraction of metals from ores, or to the refining of metals. Among the subjects treated we may mention the refining of copper and antimony, the parting of ore silver, the production of aluminum and its alloys, and the manufacture of carborundum, the new abrasive material. These subjects are also treated in the Course of Mining Engineering as a comparatively small but important part of the work in Metallurgy.

During the past summer Prof. Hofman made an extended tour, including Omaha, Kansas City, Black Hills of Dakota, and Colorado, with a view to obtaining the latest data on the metallurgy of silver and lead. Some of the results of these investigations will be embodied in the new addition of his Metallurgy of Lead, a book already accepted everywhere as authority.

In the Civil Engineering Department a new building for pendulum and magnetic observations it is expected will be erected and partially equipped during the present college year. With this addition the facilities of the Institute for instruction in Geodesy and Practical Astronomy will be greatly increased.

A course in Railway Signals, given at the Institute by Mr. G. W. Blodgett, is, we believe, the only course of its kind in the country. It deals with many interesting problems in railway and electrical engineering, in which the safety and convenience of the public are concerned. The greatest activity of railway engineering in the next few years is likely to be in the arrangement of station grounds and the development of signals. In this connection the present course will be valuable and timely.

Mr. Blodgett is a graduate of the Institute and holds the position of electrician on the Boston & Albany R. R. As an authority on the subject of signals, he has long been well known.

The first exercises in the course are devoted to an account of the different kinds of signals—including the old-fashioned hand-signals, semaphores, disk signals and others; the purposes for which they are used and their proper location are also shown, especial attention being given to problems arising in the case of obstructions, curves and considerable changes of grade.

Line Block Signals and their advantages are considered, and arrangements for operating them, including the different methods of making the electric circuit operate the signals, are thoroughly discussed. The different systems of interlocking signals are also treated.

To illustrate the various points under discussion, the Institute has acquired, either by purchase, gift or loan, a fine collection of models, many of which are of full size, and connected with a short line of track so as to demonstrate their workings in railway practice. In the latter part of the course the solution of special problems is considered, such as the protection of highway grades and the application of electricity to interlocking systems.

This course, which has been given at the Institute since 1884, is taken by all students of Electrical Engineering and by a large part of the students in Civil Engineering. During the course two or more excursions are usually made to interesting examples shown in use in this vicinity, as, for instance, the interlocking system at the Union Station, with its excellent pneumatic and electrical arrangements.

In the courses of instruction offered in its higher classes the Institute has for many years attached great importance to occasional lectures or courses of lectures given by men actively engaged in professional occupations or especially conversant with some of the practical applications of scientific knowledge.

The alphabetical list of lecturers for the current year now includes the following, although distinguished engineers or other experts not here mentioned may be occasionally secured for one or more lectures: Mr. Louis Bell, Ph. D., on the Electrical Transmission and Utilization of Power; Mr. G. W. Blodgett, S. B., on the Applications of Electricity to Railway Signalling; Mr. Henry Carmichael, Ph. D., on the Electrolysis of Brine; Mr. William R. Copeland, A. B., bacteriologist of the Lawrence Experiment Station of the State Board of Health, on the Bacteriology of Water and Sewage Purification; Mr. Howard C. Forbes, S. B., on Commercial Electric Testing; Mr. John R. Freeman, S. B., on the Hydraulics of Fire Protection and on Fireproof Construction; Mr. Hollis French, S. B., on Electrical Engineering Practice and Specifications; Mr. Hammond V. Hayes, Ph. D., on Telephone Engineering; Mr. Henry M. Howe, A. M., S. B., on Metallurgy; Mr. Daniel D.

Jackson, S. B., Assistant Biologist of the State Board of Health, on the Microscopical Examination of Water Supplies; Mr. Charles D. Jenkins, S. B., State Inspector of Gas and Gas Meters, on Illuminating Gas and on Pottery and Tiles; Mr. Simeon C. Keith, Jr., S. B., expert bacteriologist, on Industrial Biology; Mr. Ernest LeSueur, S. B., electrical engineer, on the Industrial Application of Electro-Chemistry; Mr. Arthur D. Little, on the Making of Paper; Mr. James W. Loveland, S. B., on the Manufacture of Soaps; Mr. Samuel W. Mead, on Architectural Design; Mr. Walter S. Moody, of the General Electric Co., on Transformers; Mr. Odin B. Roberts, S. B., A. M., LL.B., on the Nature and Function of Patents for Inventions; Mr. Louis J. Schiller, on Sugar and Sugar Refining; Professor Elihu Thomson, on Recent Developments in Applied Electricity.

Yale University.—A press dispatch, dated Jan. 24, says:

> The decision of the city authorities, made some time ago, adjudging the property of Yale University liable to full taxation, and thus raising Yale's taxes from $58,000 to $439,000, approximately, has excited a large amount of interest and discussion among students of late, as well as the factulty and the local press. Much indignation is felt at the unfriendly act. Yale has never had, and has not now, sufficient funds, with which to be properly equipped and managed, and this decision, if put in practice would seriously cripple the University. The act will be contested in the Superior Court.

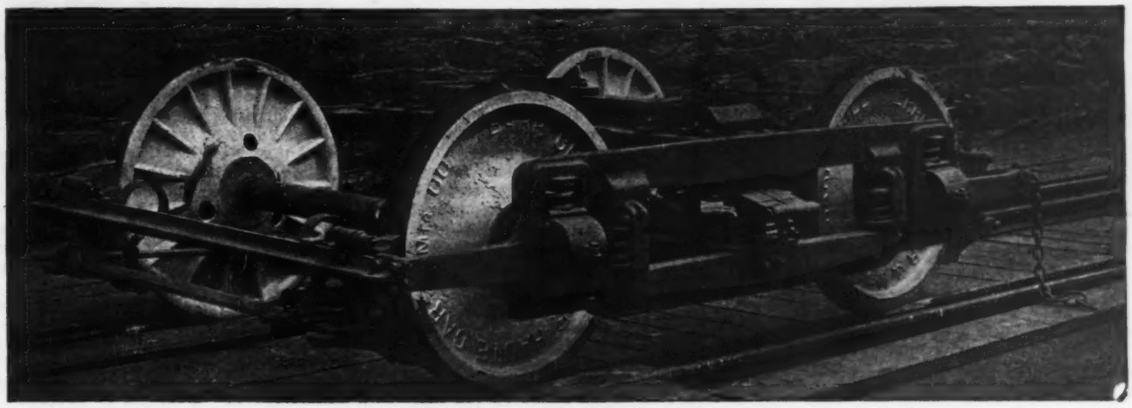
Ohio State University, Columbus, O.—The College of Engineering has issued a 4-page circular, University Bulletin No. 13, calling attention to the facilities it offers for the education of artisans, mechanics, draftsmen, etc. This college seems to be pursuing a different plan from the one adopted by most of the engineering schools, which are generally raising their standards of admission so as to exclude those who have not had an academic training at least equal to that given in the first two years in an ordinary college. It has arranged "short courses," and admits to them without examinations any student over 18 years of age. For entering the regular courses, an examination in the subjects commonly taught in high schools is required, or normal or high school certificates will be accepted in place of examination. Full credit is given for shopwork, drafting, laboratory or field work done before entering upon the short courses, so that more time is available for the remaining studies. Tuition is free, and expenses for room, board, books, fees, etc., are estimated at $150 per annum, and many students earn their support while prosecuting their studies by working on the University farm or in the shops and laboratories. Prof. Wm. T. Magruder, M. Am. Soc. M. E., is now head of the Department of Mechanical Engineering, succeeding Prof. S. W. Robinson, resigned. He was formerly at the head of the same department in Vanderbilt University.

The Brooklyn Institute of Arts and Sciences.—This institution expects to have its new building at Flatbush Ave. and Eastern Parkway completed by March 15. The dedication of the building and an exhibition of its various departments will be held some time in the spring. The Institute is noted for its numerous courses of lectures on a great variety of educational subjects. The lecture courses are in charge of the departments which are as follows: Anthropology, archeology, architecture, astronomy, botany, chemistry, domestic science, electricity, engineering, entomology, fine arts, geography, geology, law, mathematics, microscopy, mineralogy, music, painting, pedagogy, philology, photography, physics, political science, psychology, sculpture, zoology. A number of prominent citizens of Brooklyn are making an effort to establish a branch of the Institute in the Eastern District of the city in the vicinity of Broadway and Bedford Ave.

A NEW TRUCK FOR HIGH SPEED ELECTRIC CARS.

A car truck with some decidedly novel features is now being introduced by the J. G. Brill Co., of Philadelphia, Pa., and is illustrated in the accompanying cut. The spring plank has at each end an equaliser whose ends are hung by links from the top bar of the frame. The equalisers form a part of the spring plank, and these, with the swing bolster, move together in the side motion. The truck is claimed to have exceptional longitudinal stability, and its ends do not tip when the brakes are applied. The truck has a wrought iron frame, with forged jaws, solid extension pieces and T-iron end pieces. The jaw straps and transoms are of angle iron, and the spring plank is formed of two Z-bars with wood filling between them. The equalisers are forged bars, and their cast steel links or stirrups carry 8-in. helical springs having an eyebolt screwed into a follower on top of the spring. The eye of this bolt carries the end of the equaliser. Helical springs are placed over the axle boxes, and elliptical springs between the spring plank and bolster.

There are 32 of these trucks now in service on the Buffalo & Niagara Falls Electric Ry., and 22 on the Akron, Bedford & Cleveland Ry. The former road uses also the ordinary pivoted trucks, and these trucks are occasionally derailed, but no such accident has occurred to the new style of truck, which is considered specially adapted for suburban and interurban electric railways, where high speeds are maintained, but where the track conditions necessitate the use of wheels with narrow treads and shallow flanges.



TRUCK FOR HIGH SPEED ELECTRIC CARS.
J. G. Brill Co., Builders.

IRON ORE DOCKS ON THE GREAT LAKES.

The extent of the iron ore trade on the Great Lakes is indicated by the statement that the aggregate storage capacity of the ore pockets at all the docks on the upper lakes is over 580,000 tons. The accompanying table, showing the details of the various docks has been compiled by Mr. Hiram J. Slifer, of Kaukauna, Wis., Engineer of the Ashland Division of the Chicago & Northwestern Ry. We are indebted to him for the privilege of reproducing it here.

List of Iron Ore Docks on the Great Lakes, with Principal Dimensions and Storage Capacity.

Railway.	Location.	No. of Dock.	No. of Pockets.	Storage capacity. tons.	Height: Water to center hinge hole. ft. ins.	Height: Water to deck of dock. ft. ins.	Width of dock. ft. ins.	Length of spouts. ft. ins.	Remarks.
Chicago & Northwestern Ry.	Ashland, Wis.	1	234	36,936	32 10	54 0	46 8	27 0	Length dock, 1,404 ft.[1]
	" "	2	234	24,156	23 10	45 0	46 0	27 0	" " 1,404 ft.[2]
	Escanaba, Mich.	1	184	24,104	28 10	48 6	37 0	21 0	" " 1,104 ft.
		2	192	20,928	24 1	40 3	37 0	21 0	" " 1,152 "
		3	226	30,284	31 2	52 8	37 0	27 0	" " 1,356 "
		4	250	32,750	28 10	48 6	37 0	21 0	" " 1,500 "
		5	232	43,152	28 6	53 3	37 0	21 8	" " 1,392 "
Duluth & Iron Range R. R.	Two Harbors, Minn.	1	141	18,000	26 10	45 6	41 0	23 0	
		2	176	23,900	27 9	46 6	41 0	23 0	
		3	90	16,000	28 10	51 6	49 0	23 0	
		4	168	30,000	28 10	51 6	49 0	23 0	
		5	168	33,000	30 0	54 0	49 0	25 0	
Duluth, Missabe & Northern Ry.	Duluth, Minn.	1	384	57,600	30 0	53 0	52 0	27 9	
	" "	2	192	34,560	32 0	57 6	52 0	27 9	
Duluth, So. Shore & Atlantic Ry.	Marquette, Mich.	1	270	27,000	25 0	45 0	40 0	.. ..	
		3	213	12,780	23 0	37 0	53 6	.. ..	
		4	200	28,000	27 9	47 3	36 8	21 1	
Duluth, Superior & Western Ry.	Allouez Bay, Superior, Wis.	1	160	15,000	29 9	52 0	49 8	26 0	Old part.
			150	25,500	33 0	57 0	49 8	27 3	New extension.
Lake Superior & Ishpeming Ry.	Marquette, Mich.	1	200	36,000	30 9	54 0	52 0	24 7	Length dock, 1,200 ft.
Minn., St. P. & S. Ste. Marie Ry.	Gladstone, Mich.	1	120	15,000	26 8	47 0	37 0	21 8	Angle of pocket, 40°.
Wisconsin Central Lines	Ashland, Wis.	1	314	33,500	31 4	54 6	36 0	27 0	
				581,250					

[1] On dock No. 1 at Ashland the pocket floor is at an angle of 39° 30'.
[2] On dock No. 2 at Ashland, the pocket angle is 42°, except on 24 special pockets, whose hinge is 31 ft. 9 ins. above the water and whose pocket angle is 45°.

COAL-HANDLING MACHINERY AT GLADSTONE, MICH.

By Karl J. C. Zinck, C. E.*

The following is a description of a coal unloading and conveying machine located at Gladstone, Mich., on the docks of the Minneapolis, St. Paul & Sault Ste Marie Ry. Gladstone is at the head of Green Bay, at the north end of Lake Michigan. The machines were designed and built by the C. W. Hunt Co., 45 Broadway, New York city. The dock has a width of 500 ft. and length of 800 ft., with a capacity of 300,000 tons of coal.

Running parallel with the face of the dock and elevated about 30 ft. above the dock is a 15-ft.

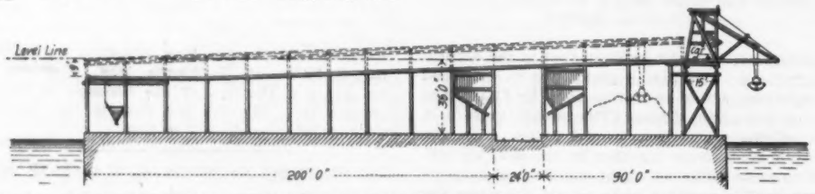
*Civil Engineer on the Erie & Ashtabula Division of the Pennsylvania Co., New Castle, Pa.

gage track, on which are moved, by hand, eight hoisting machines. Each machine has a double engine 8¼ × 10 ins., with a speed of 300 revs. per minute. The drums of the machines are 3 ft. in diameter. Steam is supplied from a power house

View of Coal Hoisting Machines on the Gladstone Dock.

500 ft. distant through a 6-in. pipe. Along this steam pipe are valves at equal distances apart so that a machine can be connected at different points.

Running at right angles to the face of the dock and parallel with each other are tracks of 18-in. gage, elevated at a height of 35 ft. near the face



SIDE ELEVATION OF THE COAL TRANSFER DOCK OF THE MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE RY., AT GLADSTONE, MICH.

Equipped with Coal Handling Machinery by the C. W. Hunt Co., New York.

of the dock, with a gradual decline to 25 ft. at the back. These tracks are to carry coal back from the machines as it is brought from the boats. On these tracks run small tram cars with a capacity of 1½ tons each, which can be dumped on to the dock below, into large pockets, or into cars direct. These tram cars are made with side dumps and are dumped by means of a trip set at any place along the outside of the track. When loaded the small cars run away from the machines and strike a block connected, by a cable, to a weight which acts as a counterbalance to return the car after it is emptied. Each small car is weighed as soon as loaded; there is thus no waste as in other arrangements which either throw the coal onto a dock or into pockets, and then load into cars and weigh. In each machine is a small hopper pocket which is loaded by buckets from the vessel and from which the small cars are loaded. This pocket has a controllable gate so that the buckets can be working from the vessel continually.

Each machine has an arm which, when not in use, swings into the dock so as to clear the vessel while it is getting in place. A small truck works on each arm carrying a bucket out over the vessel and then lowering it into the hold. These buckets have a capacity of 1,500 lbs. each.

The capacity of each machine or hoist is 35 tons bituminous, or 45 tons anthracite per hour. To handle this amount of coal requires the following number of men to each machine: One hoister, one weigher and six shovelers, and over all, one foreman, one trip-setter and one water-boy.

In regard to the actual work of unloading a boat, Mr. W. M. Kellie, Superintendent of the M., St. P. & S. Ste. M. Ry. gives the following figures: On Sept. 7, 1894, they received the largest cargo of bituminous coal ever loaded on a fresh-water lake boat. It was on the steamer "S. S. Currie," and consisted of 4,387 tons of Youghiogheny coal, loaded at Conneaut, O. The eight machines worked on the boat for 15 hours, taking out an average of 292½ tons per hour, or an average of 36.56 tons to each machine.

At the power house was used 9 tons and 1,340 lbs. of screenings, at a cost on the dock of $1.75 per ton, or a total fuel cost of $16.92. They used 4.4 lbs. for every ton moved, making the fuel cost 4 mills per ton. Labor for unloading the boat cost $357.09, an average cost per ton of 8.1 cts.

The following men were required: Eight hoisters, eight weighers, eight hatch tenders, 48 shovelers, one foreman, one rigger and one water-boy, making a total of 75 men.

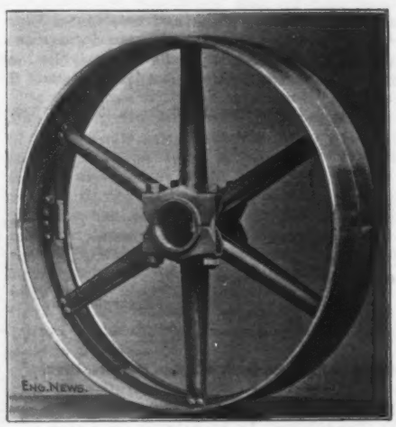
A BELT PULLEY MADE ENTIRELY OF WROUGHT STEEL.

The accompanying illustration shows a new method of constructing a belt pulley, its peculiar feature being that it is constructed entirely of mild sheet steel, no castings or forgings of any kind being used. The various parts of the pulley are cut from the material in sheet form pressed into the required shapes and then assembled into the finished pulley, all being accomplished by machinery of a special design, which produces without turning, boring, grinding or other machine work, and without hand labor, a true running pulley of perfect balance.

The high tensile strength of the steel used enables the construction of a pulley about one-third the weight of one made of cast iron and lighter in average weight than a wooden pulley.

The pulley shown in the cut is a split pulley, which may be clamped firmly on the shaft with sufficient compression to transmit as much power as is possible to carry with the heaviest belt practicable, but keys may be used when required in special cases.

In the manufacture of the pulley the rim is rolled at the outer edges, making them smooth and round. The middle portion of the rim is formed into a deep flange, which, with the rolled edges, makes the rim of a minimum thickness of metal and at the same time exceedingly strong.



Belt Pulley Made of Wrought Steel.

Manufactured by The American Pulley Co., Philadelphia, Pa.

The double spoke arms are stiffened by a deep corrugation through their entire length making the spider of the pulley very strong and rigid. The inner ends of the spoke arms are shaped so as to form sections of the hub, and the hub clamps encircle the hub portion of the arms, binding them firmly to the hub shells which form the bearing for the pulley on the shaft, all being riveted strongly together.

By means of steel bushings the pulleys are made interchangeable to fit different diameters of shafts.

In addition to the lightness and perfect running balance of this pulley one of the great merits claimed for it is that it is made throughout of a material of known strength, and is therefore not subject to the uncertainty which is unavoidable in the use of cast iron, and as variations in the quality and grain of the metal, blowholes, shrinkage strains, etc. The bending and compressing of the parts of the steel pulley during manufacture, while probably not greatly increasing the ultimate strength of the steel, raises its elastic limit and thus increases the available or working strength.

The pulley is the invention of Mr. Thos. Corscaden of New Britain, Conn., who has also developed special methods of manufacture, tools, etc., for its construction. Patents in this and foreign countries have been issued, and others are now pending, all of which are the property of the American Pulley Co., 18th and Hamilton Sts., Philadelphia, Pa., which has fitted a factory with the machinery necessary to turn out these pulleys in large quantities and various sizes.

Mr. Geo. V. Cresson, who is at the head of the Geo. V. Cresson Co. the well-known manufacturers of machinery for transmission of power, is President of this company; Mr. Henry Morris, Secretary, and Mr. Giles L. Reynolds, Treasurer.

A REPLY TO THE EXPERT REPORT ON THE PROPOSED JERSEY CITY WATER CONTRACT.

In our issue of Jan. 21 we abstracted a report by Mr. Geo. W. Rafter, M. Am. Soc. C. E., on the proposed contract between Jersey City and the East Jersey Water Co. for a new water supply for the former. The report was made to the Board of Trade of Jersey City and has since been answered by Mr. C. C. Vermeule, Consulting Engineer for the new supply.

Mr. Rafter criticised the tables for the yield of drainage areas given by Mr. Vermeule in his "Report on Water Supply," and adopted in the specifications as a basis for judging the capacities of the drainage areas offered by bidders. To this criticism and to Mr. Rafter's claim that the drainage area of 66.4 sq. miles offered by the East Jersey Water Co. is somewhat too small to yield 50,000,000 gallons per day, Mr. Vermeule urges that his conclusions are founded on twenty years of intimate knowledge of drainage areas which he does not think Mr. Rafter has ever seen. Mr. Vermeule states further:

> I can give no more time to this * * * * argument, except to say that to supply 50,000,000 gallons daily from the 66.4 sq. miles of drainage area requires 753,000 gallons daily from each sq. mile. After 60 years experience with the Croton watershed, a number of able engineers have agreed that 800,000 gallons daily per sq. mile can be collected therefrom. Mr. Rudolph Hering, in his report on a new water supply for the city of Philadelphia, made, in 1886, estimates that 828,000 gallons daily per sq. mile can be collected from the Neshaminy and Perkiomen Rivers. This is sufficient to show that my conclusions are well supported by the opinion of engineers. * * * *

Regarding the number of conduits called for by the specifications, Mr. Vermeule maintains that the plural was used not to designate parallel conduits, but the various separate stretches of pipe that might be necessary in connection with the several bids. As to the use of the duplicate conduits elsewhere cited by Mr. Rafter, it is pointed out by Mr. Vermeule that the second conduits at New York, Boston and Rochester were built some years after the first, as a means of affording additional supply, while the city of Syracuse has but recently built new works with a single supply conduit nearly twenty miles long.

Regarding the indefiniteness of the specifications, which was one of Mr. Rafter's main criticisms, the reply sets forth at some length that the conditions under which this work would be done required broad general specifications, as contractors would not assume all the risks involved in furnishing

water rights, building, owning and operating works on any other basis than one allowing them to determine the character of the details of construction. It is urged further that the fact that the contractor is expected to operate the works for a number of years is an added guarantee of good construction.

The great disadvantage of trying to secure a water supply along the lines followed by Jersey City and the unlikelihood of competition under such a plan have often been pointed out by this journal. It is interesting to note Mr. Vermeule's views on the same subject. He says:

> There is one difficulty in this method of obtaining a supply of water. It must result in a degree of indefiniteness in every bid received, not because of the form of the specifications or from lack of time to prepare bids, the latter being the usual excuse offered, but from the simple fact that no bidder can afford to spend the large amount of money necessary to make complete surveys and specific plans before making his bid. If his bid is unsuccessful he loses every dollar invested. * * * * The bids are necessarily somewhat general in character. If they are required to be more elaborate, the result will be that no bids will be received. For this reason I do not think it wise for the city to proceed much further on these lines. The present specifications were intended to secure, if possible, an offer of some source of supply not controlled by the Morris Canal. None such were offered. If a re-advertisement on a slightly modified plan will secure such a really competitive offer, it may be worth while to re-advertise.

Mr. Vermeule next states that the alternatives are the securing of water through a state commission, which he disapproves, or the building of municipal works. He closes his report with an approval of municipal construction, as a general proposition, although not believing it would save the city much money, besides making necessary some very important enabling legislation. These views are expressed as follows:

> The plan to have the city itself build the works is one which, in common with most engineers, I should prefer. It seems the most orderly and usual method of procedure, and one more in consonance with the spirit of our institutions. It also leaves an important matter affecting the public health and prosperity in your own hands, subject to your immediate control. These considerations make it an attractive course to pursue so long as your city is wisely and economically administered. After carefully estimating the cost of works built in this way, I cannot truthfully say that I think it would result in any material saving of money. I know that a few of the members of my profession have a habit of making low estimates in order to get such works started. If you take this step with my advice I would prefer that you do it with your eyes open to the truth. At the price offered the East Jersey Water Co. will make 10% on the cost of construction, and will obtain a good price for their water rights. There is no possible way that you can avoid these profits. If you build municipal works you must still allow 10% on the cost of construction and must expect to pay a good price for the water rights. In my experience, when condemnation proceedings are contested with a strong hand, a good price is usually obtained for the properties.
>
> To enable the city to build, two laws will be necessary, one giving you power to condemn the Morris Canal rights and another allowing an issue of about $7,000,000 of bonds for construction. If the mayor should see fit to advise this course, he would need your cordial support to secure this legislation. One of these bills was introduced last winter, but it does not appear that the citizens gave it very strong support.
>
> Some misguided persons seem to have assumed that I have urged the city to make this contract now under discussion. Nothing is further from the truth. My province as consulting engineer has been simply to answer engineering questions and keep the officials informed thereon. They must decide whether it is, on the whole, best to accept the bid, to re-advertise or to endeavor to obtain legislation, issue bonds and build the works. What I object to is not the opposition to the proposed contract, but the ground for that opposition.

A PROPOSED BRIDGE FROM FORT WASHINGTON TO KINGSBRIDGE, NEW YORK CITY.

The accompanying illustration shows the preliminary design for a proposed bridge from the bluff at Fort George, across Sherman's Creek to the low lands surrounding Kingsbridge in the upper part of New York city. The mouth of Sherman's Creek is an arm of the Harlem River projecting into the west bank just north of Fort George. The creek bottom is low and marshy and Kingsbridge Road, which is the only highway extending through to the north point of Manhattan Island, makes a wide detour to the west to avoid the bluff and marshes.

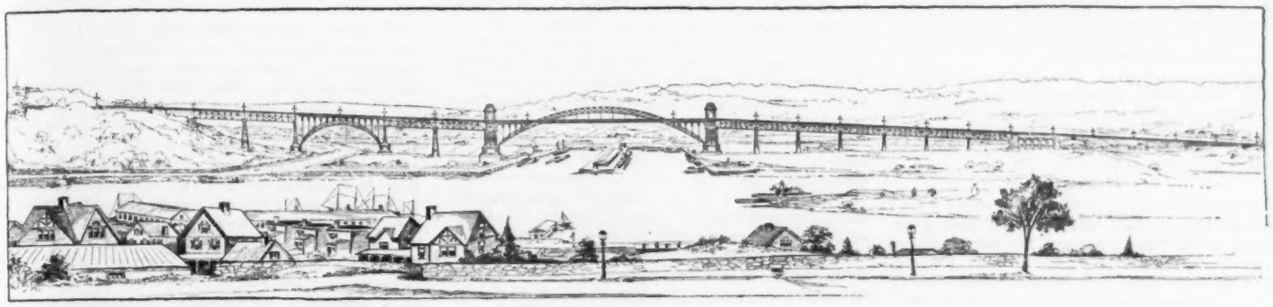
The purpose of the bridge is to develop the region surrounding Fort George. It will extend in a straight line from the bluff at the northern end of Amsterdam Ave. to Kingsbridge. It forms a tangent to Fort George Ave. which is a semicircle, connecting Eleventh and Amsterdam Aves. around Fort George. The elevation at this point is about 120 ft. above that where the north end of the bridge will join the Kingsbridge Road just before it reaches Spuyten Duyvil Creek.

The bridge would occupy a conspicuous position parallel to the Harlem River and opposite Morris Heights about ¾ mile above Washington bridge.

The total length of the structure is 3,000 ft., 2,000 ft. of steel and the balance of masonry and earth fill. In order to reach the low land to the north a continuous grade of 5% will be maintained except where the roadway passes over the main arch. This arch is 515 ft. long between pin centers, supported on two steel ribs, 40 ft. apart. The roadway will be carried between these ribs and a 10-ft. sidewalk will be hung on cantilevers on either side, making the total width 60 ft. The rise will be 90 ft. and the crown will be 126 ft. above low tide. The piers will be of solid masonry.

The small arch over the speedway at the foot of Fort George will be a 200-ft. span and 86 ft. in clear height. The steel piers supporting the roadway between and beyond the arches will have narrow bases and be so braced as to form practically a single column. The estimated cost of the structure is $1,400,000.

The design was made by Mr. W. B. Parsons, M. Am. Soc. C. E., 22 William St., New York city, from whom the information and illustration for this article were obtained.



PROPOSED BRIDGE OVER SHERMAN'S CREEK, NEW YORK CITY.
Designed by W. B. Parsons, M. Am. Soc. C. E., New York City.

THE BLOT STORAGE BATTERY, invented by Mr. G. R. Blot and lately tested in London, possesses the following distinctive features: Two lead ribbons, each 1-50 in. thick and not pasted with oxides, one being corrugated longitudinally and the other corrugated crosswise, or it is embossed. These two ribbons are laid together and wound into a tank, like tape, and in the center of this tank is a lead core burned to all the layers of ribbon and putting them into electrical contact with each other and the core. Four or six of these tanks are fixed in an open lead frame by burning the ends of the core into the frame, and such a frame makes one plate of a cell. This Blot plate is perfectly elastic, as the ribbons only touch each other at points and are free to expand and contract in any direction. Their exposed surface is very large, being 0.33 sq. m. per kilogramme of weight. The storage capacity is thus great and the rate of charge and discharge can be rapid, as no buckling need be feared. "Engineering" says that 12.7 ampere-hours have been obtained per kilogramme of plate, and the ampere-hour efficiency, was 88%, and the watt-hour efficiency, 76% at the normal rate of discharge. At 2 volts pressure, this would give 25,400 watt-hour storage per metric ton of plate, or 34 electrical horse-power hours.

BOW TORPEDO TUBES are to be removed from all the war vessels, by order of Secretary Herbert, says a Washington press dispatch. The reason assigned is the danger of insufficient speed of the torpedo allowing the ship discharging it to catch up with it and explode it. This action seems like a step backward in the art of naval warfare. It would seem that the danger might be avoided by giving the torpedo sufficient motive power to insure that it would always keep ahead of the vessel, or by reversing the engines of the vessel immediately after discharging the torpedo.

TORPEDO BOAT NO. 6, built by the Herreshoffs, is said to have exceeded her contract speed of 27½ knots per hour in her recent trial at Newport, and is believed to have made nearer 30 knots. The test was unofficial and was made with 200 lbs. steam pressure, instead of 225 lbs. allowed by the contract.

ALABAMA PIG IRON to the extent of 90,000 tons has been sold for export since July last by the two leading companies in that state, according to President Haas, of the Ilioss Iron & Steel Co., of Birmingham, Ala. It is said that the prices obtained are at least as satisfactory as those obtained at home. The difficulty in procuring ship room for export tends to limit the shipments. The amount named, 90,000 tons, is just about 1% of the total annual production of pig iron of the United States.

THE FRENCH SOCIETY OF CIVIL ENGINEERS has built and officially opened on Jan. 14 a new society building in Paris, at No. 19 Rue Blanche. The building is a handsome structure externally, six stories in height and occupies an area of 7,532 sq. ft., or about 100 × 75 ft. The hall for meetings covers nearly 2,600 sq. ft. and will seat 500 persons. A large library room and a number of offices are included. The French Society of Civil Engineers was founded in 1848 with 100 members; with 1,000 members in 1870, it built its first society building; and now, with 2,724 members, on Dec. 31, 1896, it has enlarged its quarters as above stated. The total cost of construction was about $110,000, and $80,000 was paid for the real estate. Work was commenced upon the new building on March 29, 1896, and the first meeting was held in this building, nine months after that, or on Dec. 17, 1896. The inaugural ceremonies were attended by M. Felix Faure, President of the French Republic, and the Ministers of Commerce, and of the Colonies, the Prefect of the Seine and others prominent in civil and military life.

A MACHINERY EXHIBITION will be held in Munich, Bavaria, from June 1 to Oct. 10, 1898, to which manufacturers of motors and machine tools of all countries are invited. The General Industrial Association of Munich celebrates by this exposition its fiftieth jubilee, and will have the co-operation of the Polytechnic Association and also the patronage of Prince Luitpold, Regent of Bavaria.

MANCHESTER SHIP CANAL TRAFFIC is improving. The approximate returns for December, 1896, were $88,570, as compared with $62,275 for the corresponding month in 1895. For the 12 months the total receipts were $899,170, as compared with $683,795, for 1895. The aggregate traffic amounted to 1,826,237 tons, a gain of 467,362 tons over the previous year; 422,215 tons of this gain being due to sea-going traffic.

SUBMARINE CABLES in existence, says "The Engineer," number 1,300, with an aggregate length of not less than 162,000 nautical miles. Classified by length, there are 761 under 5 miles long; 223 between 5 and 50 miles; 65 between 50 and 100 miles; 155 between 100 and 500 miles; 64 between 500 and 1,000 miles; 29 between 1,000 and 2,000 miles, and 8 lines exceeding 2,000 miles in length.

THE PATENT OFFICE RULES OF PRACTICE are soon to be issued in a wholly revised and much condensed form. The aim in making the new rules, says the Commissioner of Patents, is to simplify the code of practice and liberalize it. The new rules will make a pamphlet of about 20 pages, or about one-third of the size of the old pamphlet.

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The specifications for the official survey of a certain village in the State of New York have been forwarded to us with a request for our criticism upon them. These specifications crudely attempt to define what is to be done by the "contractor;" otherwise, the engineer or surveyor who is supposed to submit a bid for making the survey, under heavy penalties for not completing it in 90 days after signing the contract. The chief requirement is that the contractor must run survey lines

entirely around each block, and checking the same by calculations known as latitudes and deparatures, and all survey lines to be plotted by rectilinear co-ordinances (sic), or by other equally well recognized methods.

In case of dispute between the Board of Trustees and the contractor, as to the agreement of the work with the terms of the specifications, the disagreement is to be referred "to three reputable civil engineers for adjustment."

Our advice to this village Board is to throw away these specifications, and to then engage the services of one reputable civil engineer to make the survey required. Under the existing conditions of past faulty work in village surveys, the desire for more accurate and reliable results can alone warrant the expenditure of public money for the purpose proposed. This end cannot be secured by awarding a contract for the survey to the lowest bidder, regardless of fitness or previous training. The only safe procedure is to secure the services of a reputable surveyor or engineer, and to depend upon his reputation and professional integrity to secure good results. If the board does not feel itself competent to make this selection, it can always call for the advice of the reputable engineers referred to. It is true that engineers of reputation do make contracts sometimes for making ordinary land subdivisions, or when the conditions are plainly and intelligently set forth and the work to be performed can be closely estimated. But the general practice is to give the work to a reliable man and to pay him by the day, where the amount of work is indefinite, or agree with him for a lump sum, if he feels that he can safely, and yet properly perform the work in that manner. The final accuracy and the reliability of the work performed are what should be actually paid for; and common experience is that in technical work public competition and an award to the lowest bidder secures a minimum of reliable results. Unfortunately too many village boards fail to appreciate the extent of the responsibility resting upon them in expending public funds; and in securing the professional services of an engineer they either select some well-meaning but incompetent local land surveyor, or if they engage outside parties they measure results solely by the standard of cost. Experience in the cost and litigation to which bad surveying leads can alone check this tendency. But there is an encouraging promise of better practice in the fact that the errors of old surveys are being sufficiently recognized to call for revision; and the growth in general intelligence will soon convince those interested that reliable technical work in this field is worth all it may cost.

The bill to regulate sales of railway tickets which has been introduced into Congress by Representative Sherman of New York is one worthy of support by every honest man. Briefly stated the bill proposes to compel common carriers to provide all agents authorized to sell tickets with certificates of their authority, which must be conspicuously displayed in their offices. It also makes it unlawful for other persons to sell or transfer tickets or passes under heavy penalties, fixes penalties also of fine and imprisonment for counterfeiting tickets, and provides that all unused parts of tickets must be redeemed by the companies issuing them. As will be seen the legislation is directed against the so-called "ticket scalper," who despite his prevalence and very general patronage by a portion of the traveling public, has no necessary, legitimate or useful function in the transportation business, and, more than this, occupies a position, in many cases, but little more honorable than that of a "fence" for stolen goods. Every railway company has numerous accessible and convenient places at which tickets can be purchased, and this coupled with the fact that the company will redeem unused tickets leaves no economic excuse for the self-constituted middleman known as the "scalper." Laying morals entirely aside, it is evident that such men live by the margin between the prices at which they purchase and sell unused tickets, and the selling price must always be lower than that of the railway companies themselves. Yet we find the Interstate Commerce Commission asserting that the net profits of this business in the United States probably do not fall short of $1,000,000 yearly. This profit must come either from the public or the railway, and neither is by any service which the ticket scalper supplies warranted in abandoning it to him. But as a matter of fact a great portion of the scalpers' business is pure fraud and criminality, the buying and selling of passes and mileage books issued to persons for special considerations, the corruption of railway employees, the forging of dates and names, and every variety of other petty fraud and deceit. It is by rascality that the scalper makes his profit and his office places a perpetual premium on lying and theft. Congress can perform no more righteous act than to stamp his business as illegal and punishable.

Yet when all this is said the question is warranted whether the railway companies themselves are not in a very considerable measure to blame for the practice which they condemn. Have they taken the pains they could easily have taken to inform the traveling public that they stood ready to redeem unused tickets? Have they not in a measure winked at the traffic while protesting against it? The unprejudiced observer cannot help but think that their protestation is at least rather hollow in many cases, and that they have oftener contented themselves in echoing the outspoken condemnation of ticket scalping by the Interstate Commerce Commission and similar bodies than in exerting themselves to efficient action toward stamping it out.

FIREPROOF FLOOR CONSTRUCTION IN NEW YORK CITY.

I.

There has recently been brought to our notice in connection with the administration of the building laws in New York City certain matters which appear to us to be of very great interest and importance, not only to every resident of that city, but to all who are interested in the construction of fireproof buildings anywhere or who have to do with the framing or enforcement of municipal regulations respecting such construction.

The gist of the matter appears to be that under the rulings of the Board of Examiners of the New York Building Department, various fireproof floor constructions in which concrete is employed are discriminated against and the weight of official authority is thrown in favor of constructions which employ hollow tile or terra-cotta as a filling between the floor beams. If this is a necessary measure to secure a proper degree of safety, then those in authority deserve credit for their protection of the public interests. But if, as we have good reason to believe, the constructions discriminated against are in every way as safe and strong as the tile construction, then the Board of Examiners are increasing by from 10% to 20% the cost of the floor construction in every fireproof building erected; they are laying a grievously unjust and unnecessary burden on builders, landlords and rent-payers everywhere, and worse still, they are obstructing the change from the old wooden construction to fireproof construction by the builders of flat houses, tenements, stores, warehouses, and many other structures in which fireproof construction is not now required by law, and thus instead of guarding the public safety are actually conspiring against it.

We have been at considerable pains to collect and verify the actual facts of the case; and they seem to us of such importance not only to New York but to other cities where New York practice in building construction and building laws are taken as a guide that we shall present and discuss them at considerable length.

The construction of all buildings in New York City is governed by a long, intricate and frequently amended statute enacted by the legislature of the State of New York. No one, not even the legislators themselves, we venture to say, supposes that this body is competent to judge as to the proper method of computing the safe load on a column or constructing a foundation; but competent or incompetent, it has enacted a law in which these and a hundred other details of building construction are set forth and made compulsory.

At this time, however, we propose to discuss only one of these features, that respecting the floor construction to be used in fireproof buildings. The strength of all floors is, by a paragraph in the law, which we will not take space to quote in full, required to be such as "to bear safely" loads of from 70 lbs. to "150 lbs. and upwards" per sq. ft. It is also required that iron or steel floor beams shall not deflect more than 1-30 in. per lineal foot of their span and shall be tied together at intervals of not more than 8 times the depth of the beam. Then follow the requirements as to fireproof floor construction which we quote verbatim:

All brick or stone arches placed between iron or steel floor-beams shall be at least 4 ins. thick and have a rise of at least 1¼ ins. to each foot of span between the beams. Arches of over 5 ft. span shall be properly increased in thickness, as required by the Superintendent of Buildings, or the same space between the beams shall be filled in with sectional hollow brick or hard-burnt clay, porous terra-cotta or some equally good fireproof material, having a depth of not less than 1¼ ins. to each foot of span, a variable distance being allowed of not over 6 ins. in the span between the beams.

The exceeding crudity of this paragraph is evident even to the casual reader. It was doubtless drafted in the days when the standard mode of fireproof floor construction was by brick jack arches between the floor-beams, and the paragraph actually contemplates this as the standard construction, and only refers to the styles of construction which are now in general use as a permissible alternative. It is an instructive example of the carelessness with which such important statutes as this are drafted that if we adhere to the actual grammatical construction of the above paragraph, what it really says is that the hollow brick or terra-cotta construction shall be used on arches of over 5 ft. span as an alternative to the use of "brick or stone arches" over 4 ins. thick. But those who execute the laws are of course obliged to construe them in such a manner as to re-

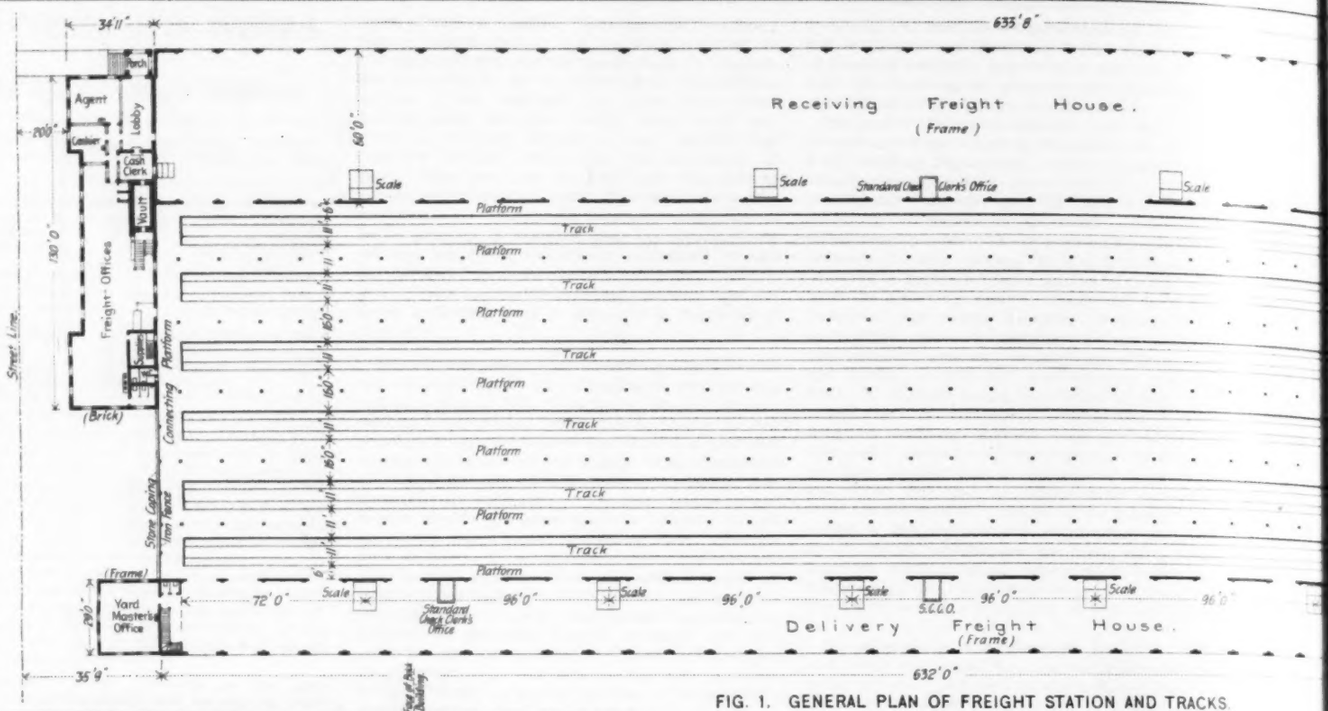


FIG. 1. GENERAL PLAN OF FREIGHT STATION AND TRACKS.

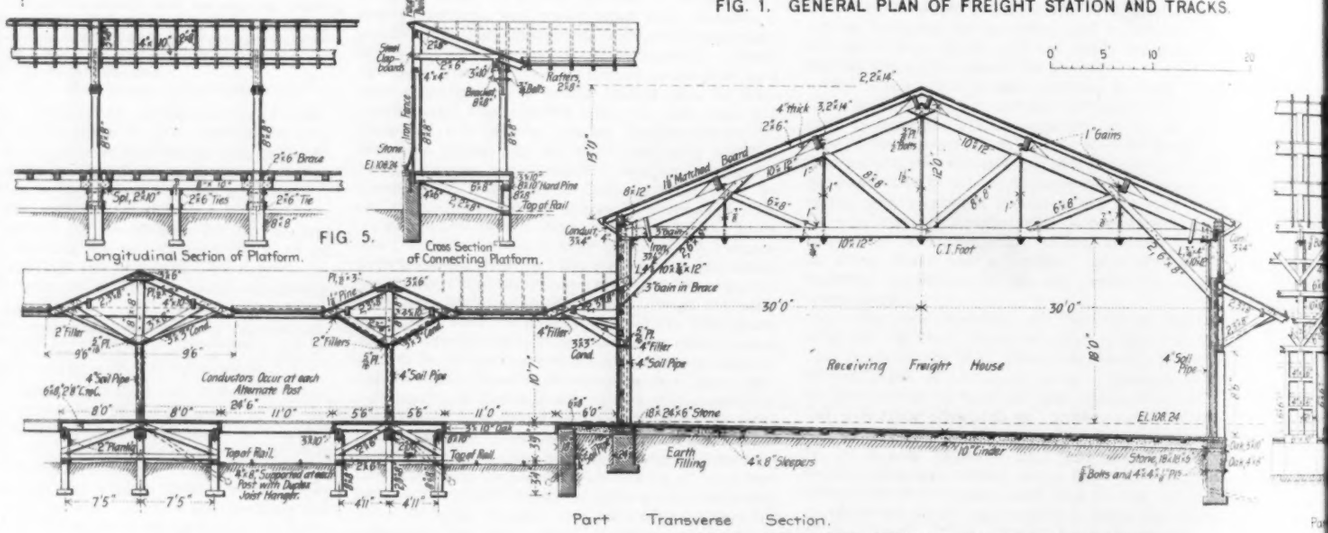


FIG. 5.

FIG. 4. RECEIVING FREIGHT HOUSE AND PLATFORMS.

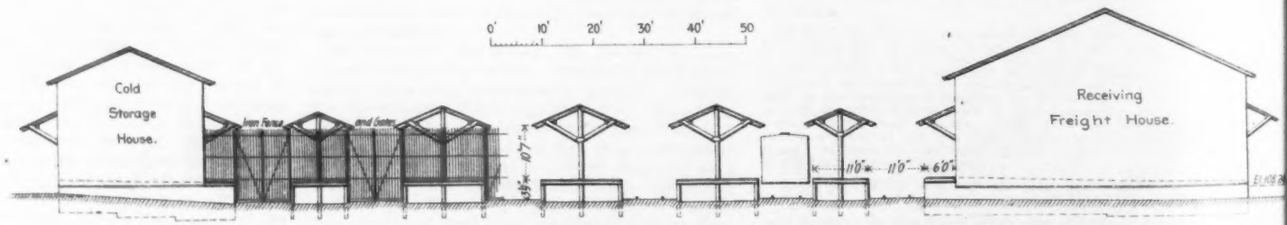


FIG. 3. ELEVATION OUTER END OF FREIGHT STATION.

THE NEW FREIGHT STATION OF THE PITTSBURG, CIN[illegible]NNA[illegible]

Thos. H. Johnson, M. Am[illegible] Soc. [illegible]

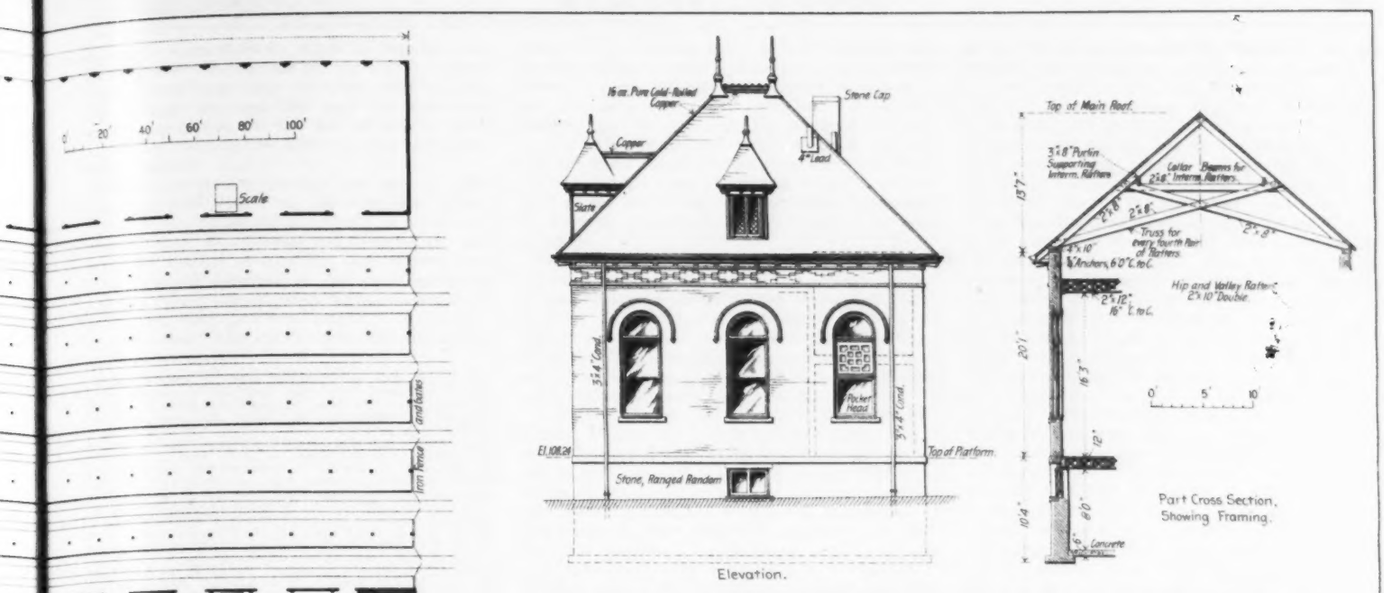
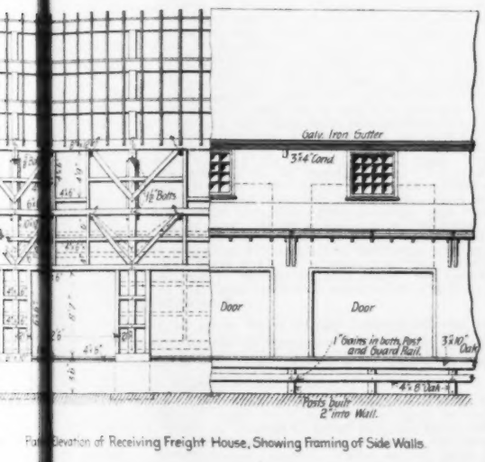


FIG. 7. END ELEVATION AND PART CROSS SECTION OF OFFICE BUILDING.



Part Elevation of Receiving Freight House, Showing Framing of Side Walls.

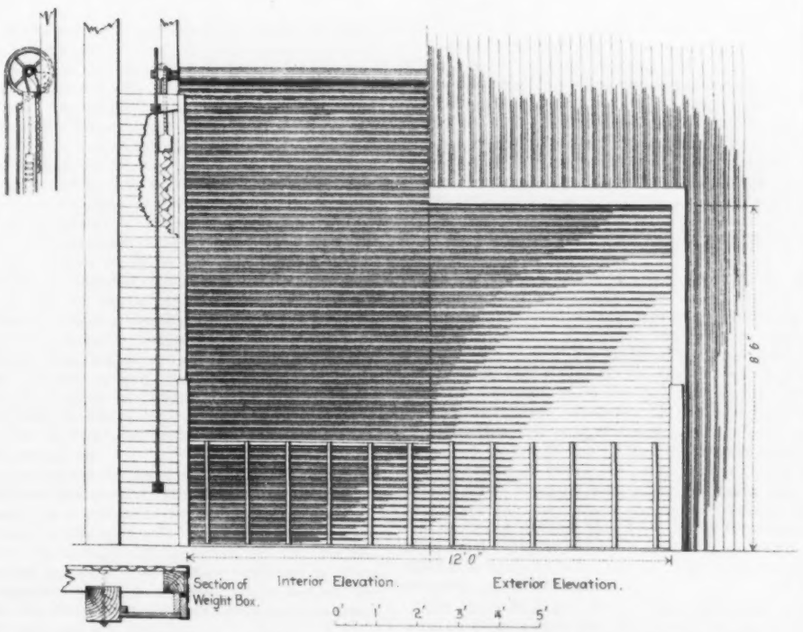
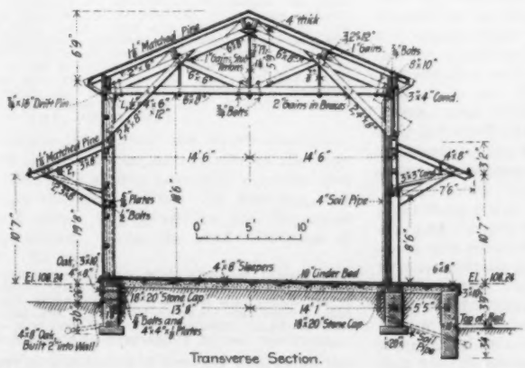


FIG. 8. DETAILS OF ROLLING STEEL DOOR FOR COLUMBUS FREIGHT HOUSE.
Made by the Kinnear & Gager Co., Columbus, O.



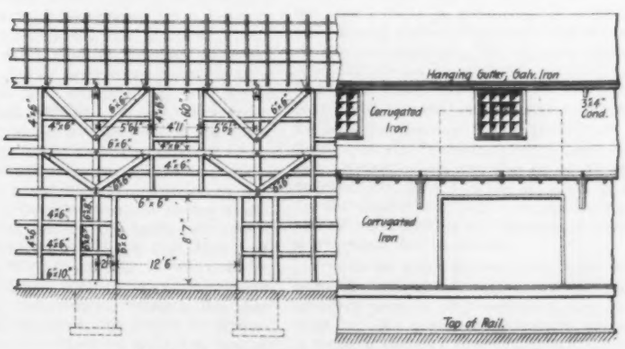


FIG. 6. DELIVERY FREIGHT HOUSE.

CINCINNATI, CHICAGO & ST. LOUIS RY., AT COLUMBUS, OHIO.

M. Am. Soc. C. E., Chief Engineer.

CHAS. HART & SONS, LITH., 32 VESEY ST., N. Y.

duce their absurdities as much as possible, and this alternative permission for the use of "hollow brick, hard-burnt clay or some other equally good fireproof material" has been construed as a general permission for the use of the flat arch hollow tile construction which is now so extensively adopted.

Let us now turn to another and most peculiar feature of this New York Building law. Whoever was responsible for it appears to have realized that they were human and liable to err, and also that the art of building construction was likely to make progress as the years advanced and thus render obsolete some of the cast-iron requirements which had been placed in the statute. To meet these conditions the following clause was added to the law:

Superintendent, Powers Of—Board of Examiners.—The superintendent of buildings shall have power (except as herein otherwise provided) to pass upon any question relative to the mode, manner of construction, or material to be used, in the erection, or alteration of any building or other structure, provided for in this title, in any part of the city of New York, to make the same conform to the true intent and meaning of the several provisions of this title. He shall also have power to vary or modify the provisions of this title, upon application to him therefor, in writing, by an owner of such building or structure, or his representative, where there are practical difficulties in the way of carrying out the strict letter of this law, so that the spirit of the law shall be observed, the public safety secured, and substantial justice done; but no deviation shall be permitted, unless a record of the same shall be kept by the said superintendent of buildings, and a certificate be first issued to the party applying for the same. Such certificate shall not be issued until a board of examiners, consisting of a member of the New York chapter of the American Institute of Architects, one member of the New York Board of Fire Underwriters, two members of the Mechanics' and Traders' Exchange of said city, one of whom shall be a master mason and one a master carpenter, one member of the Society of Architectural Iron Manufacturers of said city, one member of the Real Estate Owners' and Builders' Association of said city, who shall be an architect or builder, and one member of the New York Real Estate Exchange, Limited, who shall be an architect or builder, and the chief of said fire department, all of whom shall be appointed by their respective organizations (and so certified to annually to said superintendent of buildings), shall also approve the proposed modification of the law. The said examiners shall each take the usual oath of office before entering upon the performance of their duties. The superintendent of buildings shall be ex-officio a member of said board of examiners and be chairman thereof. In cases in which it is claimed by an owner, in person, or by his representative, that the provisions of this title do not directly apply, or that an equally good and more desirable form of construction can be employed in any specific case than that required by this title, then such person shall have the right to present a petition to the board of examiners, through the superintendent of buildings, and may appear before said board and be heard; and said board shall consider such petition in its regular order of business and, as soon as practicable, render a decision thereon. The said board of examiners are hereby authorized and empowered to grant or reject such petition, and their decision shall be final. If such decision is favorable to said petitioner, a certificate shall be issued by the superintendent of buildings in accordance therewith. At least five affirmative votes shall be necessary to the granting of any application or petition by said board. No member of said board shall pass upon any question in which he is pecuniarily interested.

Next let us turn back to the history of the recent development of fireproof floor construction. We find in a recent standard work the following admirable summary of this:

The improvements in fireproof floor construction during the past fifteen years have been many and in rapid succession. Previous to 1880 so-called fireproof floors were constructed of brick arches turned between the lower flanges of wrought iron I-beams. These arches, with the concrete used for leveling, were very heavy, and as the bottoms of the beams were unprotected and the ceiling formed by the arches was very undesirable, brick arches soon gave place to arches of hollow dense tile. The increased demand for fireproof construction, taken in conjunction with the reduction in the prices of steel and fireproofing which occurred about the year 1889, led to many improvements in the designs for hollow tile floor arches, and also to the introduction of various systems of construction based upon the use of concrete and plaster compositions, combined with steel wires, bars and cables, used in different shapes and in different ways, the chief aim of the inventors or designers being to secure the lightest and most economical floor consistent with ample strength and thorough fire protection. (Building Construction and Superintendence by F. E. Kidder, C. E., Ph. D.; New York, 1896; p. 262.)

In the pages that follow the above quotation, the author describes various systems of tile construction and also among combined concrete and metal floors the Metropolitan, the Roebling, the Ransome & Smith, the Columbian, the Expanded Metal and others. Under the head "Selection of a System," he says:

The combinations of iron with Portland cement concrete are rapidly gaining in favor, and the author believes that concrete, when properly combined with metal, makes a very strong and thoroughly fireproof construction, and that it has now been used for a sufficient length of time to fully demonstrate its adaptability to floor construction.

We have no hesitation in heartily approving the opinion which we have just quoted, in fact we are prepared to state the case even more strongly: We believe that the extensive use of iron and concrete in combination, both in this country and abroad, during the past dozen years has been sufficient to prove that fireproof floors of this type can be made which are stronger, lighter, and cheaper than the flat arch tile constructions and equally safe against fire. Further on in this article we shall discuss the relative merits of these constructions in more detail; but we will now turn back to the New York Building Department and its work in connection with fireproof floor construction.

One of the systems of concrete and metal construction which has been most extensively applied is that which is known as the Expanded Metal System. It is, we presume, familiar to most of our readers. It has been used in large buildings in most of the principal cities of the country and numerous tests have shown it to be an exceedingly strong and safe construction.

A year or so ago, plans were prepared by Mr. Ernest Flagg, the well-known architect, for a men's lodging house, which is now being built by Mr. D. O. Mills, and is one of the most promising pieces of philanthropic work in this field that has ever been undertaken. For a full description of this work we must refer our readers to the "Review of Reviews" for January, 1897; we can only take space here to say that it is designed to furnish clean and comfortable lodgings to working men at a price that is less than they are now obliged to pay for a miserly space in one of the filthy "hotels" that line certain parts of the Bowery.

Mr. Flagg adopted expanded metal construction for this building, which we may note gave a dead weight to the floors of only 30 lbs. per sq. ft., against at least 80 lbs. per sq. ft. for a tile construction. The plans of the iron work filed with the Building Department showed floor bays of about 6×7 ft. for the fireproof filling and a dead weight of floor of 30 lbs. per sq. ft. These plans were approved by the Building Department, contracts were awarded and work began. Some time after the fireproofing contractors began work, the Building Department notified Mr. Flagg that he was not using a "legal floor," and must petition the Board of Building Examiners for its approval. This he did but the application was rejected by the Board, which ordered work of every kind in the building stopped. After five weeks of idleness Mr. Mills and his attorney appeared in person before the Board and the work was then permitted to proceed on condition that a 3-in. channel should be placed in the center of all bays over 5 ft. in width on such floors as were not already completed.

We are informed that a member of the Board of Examiners has publicly stated that the reason for withholding approval of the expanded metal construction in this case was not that the floors were unsafe, but because the architect did not specifically state the floor construction proposed in filing his original plans—a reason which savors too much of autocratic methods to reflect credit upon the Examiners if it be true.

The action of the Board of Examiners in this case is rendered still more incomprehensible by the fact that expanded metal floors have been approved by the Board of Examiners for a 7-story apartment house at 90th St. and Madison Ave., for the residence of R. Fulton Cutting, 67th St. and Madison Ave., for an apartment house in Irving place, and for loft buildings at 481 Fifth Avenue and 34 East 10th St. On the other hand they have refused to permit the use of the construction for the second Mills hotel, which is to be erected on Rivington St.

The Roebling fireproof floor construction is another floor which is familiar to most of our readers, and which has during the past two years come into considerable use. When this floor was first introduced in New York city it was used in eight or ten buildings without any opposition from the Building Department. Within the past five or six months, however, the Board of Examiners have seen fit to interfere with the use of this floor in several specific cases which we shall briefly state as follows:

Bowling Green Building: Plans for iron work on this building were made about a year ago by Mr. Henry W. Hodge, Consulting Engineer for the Standard Structural Co., the general contractors for the building. For the floors 12 in. beams spaced 7 ft. 4 ins. apart were to be used. The plans were filed and also a petition to the Board of Examiners for the use of the Roebling floor. This petition was denied, but the Chairman of the Board (Superintendent Constable) informed Mr. Hodge that if the span was reduced to 5 ft. 3 ins. the Roebling system might be used. The plans were altered and were then approved by the Building Department. The work proceeded according to the amended plans; the Roebling floors were put in place and the building was practically completed when the architects were served with a "Violation Notice" by the Building Department setting forth that an illegal construction had been used in the building and demanding its immediate removal under the usual pains and penalties. The technical point was made that the Board of Examiners had not formally approved the construction, notwithstanding the action of the Superintendent of Buildings, above noted and the fact that two inspectors of the Department were on duty at the building daily during the six months while it was under construction. The "violation notice" was a surprise to all concerned; owners, architects, and the unfortunate contractor for the floor construction were all held up as transgressors of the law. The provisions of the statute are strict as respects its violation. Everyone who is in any way concerned in its commission is personally liable to a heavy fine, and the construction named in the violation notice is liable to be torn out and removed by the city fire department, if the owner fails to proceed with the removal within ten days, as ordered in the violation notice. Of course a petition for the withdrawal of the notice was at once presented to the Board of Examiners, but for more than three months action upon it has been delayed. That this action of the Board of Examiners really signifies nothing as respects the safety of the building is shown by the fact that the Board of Underwriters have fixed a rate upon it as low as on any fireproof office building in the city.

The Van Ingen Building:—The builders of this structure, Messrs. McCabe Bros., closed a contract for the use of the Roebling floor in this building in September, 1896. The floor beams were spaced about 7 ft. apart. An application was filed for the use of the Roebling floor and was denied. About a fortnight later the contract for the floor construction was awarded to the Metropolitan Construction Co., and the Metropolitan floor was approved by the Board of Examiners, the spacing of the iron work being the same as in the original plans. The Metropolitan floor is made up of plaster-of-paris and wood shavings. Without saying anything against this form of construction, it is at least difficult to see any valid reason why it should be allowed when a floor of Portland cement concrete is turned down.

The Park Row Building:—This famous 30-story structure on which the foundation work is now in progress was illustrated in Engineering News of Oct. 8, 1896. The architects' specifications called for either the Roebling floor or hollow tile; but the former is preferred as it is about 30% lighter and reduces by about 4,000 tons the load on the foundations. The owners also prefer this construction as its cost will be considerably less. The floor beam spacing in this building is only 5 ft., and all the suggestions made by the Department respecting the design of iron work to be used with the Roebling system have been carried out. Nevertheless the Board of Examiners has successively denied three separate petitions filed for the approval of this construction by the architect of the building and absolutely refuses to give any reason for its action.

It will be plain to every engineer and business man that the above actions by the Board of Examiners were a very serious injury to the Roebling Co. No architect or builder desires to adopt a form of construction which is frowned upon by the authorities, no matter how meritorious it may be. As a matter of fact we are informed that the Roebling Co. has been unable to secure a considerable number of contracts which it might

have had, were it not for the experiences above related. Nor was the injury it suffered confined to New York. Its business competitors were, of course, active to spread the news that the Roebling floor had been "turned down" in New York and the company has had to meet the prejudice thus engendered in doing business in many other cities and doubtless will have to do so for a long time to come.

But the Roebling Co. has not been the only constructor of concrete floors to have trouble with the Building Department. We are authentically informed that several other builders of fireproof concrete floors have had difficulty in securing approval of their construction. In fact, from the mass of evidence presented to us from various different sources, we are forced to the conclusion that the Board of Building Examiners are opposed to this form of construction, and there is no small amount of evidence which tends to show that the Examiners are determined to favor the use of tile in fireproof construction and to obstruct, as much as possible, the business of firms which furnish other forms of fireproofing. So well is this prejudice of the Examiners against concrete and in favor of tile understood that one firm which makes a combined tile and concrete construction has dispensed with the use of concrete.

Let us now inquire where the official responsibility rests for this action by the authorities. In the clause of the Building Law quoted above the societies who appoint the members of the Board of Examiners are named. The personnel of the Board is now as follows:

Stevenson Constable, Superintendent Building Department, Chairman.
Napoleon Le Brun, from the New York Chapter of the American Institute of Architects.
Warren A. Conover, from the Mechanics' and Traders' Exchange.
Edwin Dobbs, from the Mechanics' and Traders' Exchange.
Samuel McMillan, from the Real Estate Exchange.
Wm. J. Fryer, from the Architectural Iron Association.
Cornelius O'Reilly, from the Builders' Association.
F. C. Moore, from the Underwriters' Association.
Hugh Bonner, Chief of the Fire Department.

It will be seen by reading the clause of the law quoted above that all of these gentlemen with the exception of Mr. Constable and Mr. Bonner are appointed or elected directly by their societies. They are responsible for their acts to no one, and no one has power to remove them from office. Moreover, this unique tribunal is as truly a "Court of Last Resort" as is the Supreme Court of the United States. Its decisions are subject to review by no other authority and it is not obliged to and does not give any reasons for its decisions.

Of course, what we have just said does not apply to the Chairman of this Board, Superintendent Constable. He is appointed by the Mayor and his acts are subject to review the same as those of any public officer. Further, we are enabled to say authoritatively that Mr. Constable and his subordinates are in no way responsible for and are not in sympathy with this warfare against concrete and in favor of tile, which has been carried on by the Board of Examiners.

Mr. Constable's position, as stated to a member of the staff of this journal, is that all forms of fireproof construction whose strength and safety have been established should stand on an equal footing, and there should be no prejudice whatever against concrete or in favor of tile. To settle the question as to what types of construction are safe and substantial he has planned and is carrying out the most elaborate and thorough tests of the various forms of fireproof floor construction that has ever been made anywhere. As our readers will recall, full reports of these various tests have been published in this journal as they have been made.

We believe, after a careful study of the Building law, that the entire action of the Board of Building Examiners with respect to these fireproof floor constructions, has been a usurpation of powers that properly belong to the Superintendent of the Building Department. If the law allows hollow tile construction, and it is universally conceded that it does, it also allows any other "equally good fireproof material." But who shall say what is an "equally good fireproof material?" Manifestly, the Superintendent of the Building Department, for the statute says:

> The Superintendent shall have power to pass upon any question relative to the material to be used to make it conform to the true intent and meaning of the law.

Manifestly also the Board of Examiners has no authority in this case. Their authority is specifically limited to the approval of "variations or modifications in the law."

We will not take space to present the further arguments to show that this is the correct interpretation of the statute, but we will point out that the builders of fireproof floors of concrete construction will never stand on an equal footing with tile, as long as the present interpretation of the law is in force, and they are obliged to petition the Examiners for a separate approval of their construction in each and every building in which it may be used. It must be understood that at present the Board of Examiners takes the ground that the approval of a given floor construction in one building is no precedent for its use in another. Instead of approving a general style of construction once for all and then leaving it to the Building Department to examine the sufficiency of dimensions and details in each special case, the Examiners insist that every floor construction other than tile is a deviation from the law, and its use in each and every building must be separately approved. Even if the present prejudice against concrete in the Board were eliminated, this requirement would be a hardship, for the Examiners meet but once a week, and press of business might often cause an application to be delayed a month or more before approval.

It may be asked, What are the motives which have caused the members of this Board of Examiners to favor tile and oppose concrete? Into this question, however, we have decided not to enter at this time. We shall assume that their action is based on an honest belief that the tile is a safer construction, and that the concrete is not only less safe but is so unsafe that its use ought not to be allowed in any fireproof structure. Assuming that this is their belief, it is proper to ask whether this is a wise conservatism, or a piece of ignorant old fogyism. Let us briefly inquire what are the facts of the case.

As we have shown above, the hollow tile construction is in general use a comparatively recent form of construction. There were very few examples of its use before 1880, and it is only within the past ten years, since the fall in the price of structural steel has made fireproof construction common instead of a rare exception, that hollow tile has come into extended use. We know that it has been adopted in a great number of the finest and most expensive buildings, but what do we know of its actual strength and resistance to fire?

The answer to this is that our knowledge of both the strength and the fire-resisting qualities of tile floors is confined almost wholly to the results of experimental tests. Many of these have been made and their results may be fairly summed up by saying that they have shown hollow tile arches of good design and not too long span to have a strength sufficient to be safe under any load likely to be brought upon them in any ordinary building; also that their resistance to fire is entirely satisfactory, except that the dense tile is likely to go to pieces if struck by a stream of water when heated. This has been shown by actual fires in fireproof buildings of tile construction, as well as in experimental tests.

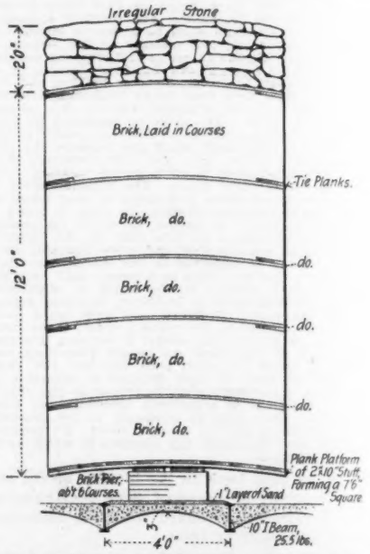
Turning now to floors made up of cement concrete and steel, we know that the extensive use of this material in Europe has nearly as long a record as has the use of tile here. We know that properly designed arches of this material have an enormous strength, much above that of tile arches of equal weight and span. Until recently, however, there has been a rather small amount of knowledge as to the fire-resisting qualities of such constructions, and while many able engineers asserted that concrete would resist fire, other authorities denied it. We may fairly say, however, that this question has been effectively settled by the series of tests inaugurated by Superintendent Constable, of the New York Building Department, and the engineering profession and the building trades owe him a debt of gratitude for this work. Some half dozen tests have now been made of concrete floor constructions, and, although the conditions of the tests are exceedingly severe, not one of these floors has failed.

All these tests have been illustrated and described in this journal, but in order to set before our readers more vividly just what an ordeal these floors have passed through, we repeat here the main facts of the test which the Roebling floor has sustained.

The floor arches were concreted on Sept. 26, 1896, and on Oct. 28 the fire test was made. The floor was loaded uniformly with 150 lbs. to the square foot and at 10 a. m. fires were lighted on the grates beneath the floor. The temperature on the underside of the floor was maintained at a temperature above 2,000° F. for three hours, and at 3 p. m. a powerful stream from a fire engine was thrown against the underside of the floor, which was at the time so hot as to glow.

After the floor cooled, on the following day, the load on the floor was increased to 600 lbs. per sq. ft., still without signs of failure.

On Dec. 11, 12 and 14 a section of one floor arch, 2 ft. 6 ins. in width and of 4-ft. span, was isolated from the rest of the floor by cutting openings in the concrete from beam to beam on each side. Upon this was built a brick pier 2 ft. 6 ins. square and a foot high, and upon this was placed a platform of plank 7½ ft. square. This was then loaded with brick and stone until a weight of 40,000 lbs. had accumulated and the pile became so top-heavy that further additions were deemed unsafe. To show just what this means we have drawn this arch and its load to scale and show



Test of a Roebling Fireproof Floor Arch under a load of 4,000 lbs. per sq. ft. after the Arch had been subjected to a fire test of Five Hours at a temperature of 2,000° and had been cooled by a stream from a Fire Engine.

them in the accompanying cut. The deflection of the arch under this load was 1 in., and after the load was removed this was decreased to ⅝-in.

It certainly seems that a concrete arch which can carry a load like this without "lying down" after such a fire and quenching test as described above is entitled to rank as first-class fireproof construction.

We are authentically informed that none of the members of the Board of Examiners, with the exception of Chief Bonner, have been present at these tests. Their condemnation of concrete floor construction appears to be based on their inner consciousness rather than knowledge — another good example of the fact that the "practical" man is much more apt to base his opinions on prejudice and fail to seek information than is the so-called "theoretical" engineer.

Finally, to conclude this long article, we desire to place especial emphasis on the point which we outlined at first—that the prejudice of the Board of Examiners in favor of tile construction lays an arbitrary tax on builder, property-owner and rent-payer, and is a grievous injustice to all those engaged in concrete fireproof construction and those who furnish materials therefor.

We are authentically informed that all the man-

ufacturers of hollow tile in the East are members of a combination which maintains the prices of fireproof tile floors at a point as high as possible without causing importations from the tile works in Ohio. Further, the laying of tile floor construction is controlled by the bricklayers' union, and all the work is done by high-priced men. For laying concrete floors, on the other hand, ordinary laborers under a competent foreman will do better work than journeyman masons, as many an engineer can testify. This again operates to reduce the cost of the concrete as compared with the tile construction.

We believe that the improvements in fireproof floor construction are by no means at an end, and further that future improvements should be in the direction of lighter and cheaper construction, while retaining ample strength and fireproofness. To delay these improvements by insisting on a rigid adherence to old forms of construction is to bar progress, and to shut the door in the way of that advance by which we hope to see durable and fireproof structures replace wooden buildings everywhere, and materially reduce that standing national disgrace, the enormous annual fire loss of the United States.

LETTERS TO THE EDITOR.

Macadam Road Construction.

Sir: Referring to the article on "A Notable Departure in Macadam Road Construction," contained in your issue of Dec. 10, I would like to say a few words in defence of macadam or telford roads.

There is no cheaper or better country road than that of the macadam or telford type, provided, that crushed stone can be delivered upon the ground for about $1.50 per ton. But as a rule, with the view of making a handsome finish and to save rolling, there is too much dirt and fine crushed stone used as a top dressing.

This top layer should be made of stone that will pass through a 1½-in. ring; and the stone dust used should not cover the larger stone, but should only fill the interstices between these stones, leaving the wear to come on the 1½-in. stone and not on a mixture of dirt and small stone rolled smooth. For the 1½-in. stone none but the hardest and best should be employed, even at a greater cost. For the first layer of the roadbed, large stone and 2½-in. stone, or even gravel can be used, as no direct wear comes upon it.

But even when you have a good macadam road, such a road can not stand a rolling load of from 4,000 to 10,000 lbs. concentrated upon a wagon tire from 1½ to 2 ins. wide. The only remedy is a wide tire law; and with this secured the macadam is the ideal type for country road construction; for a properly laid macadam road should last from 8 to 10 years without material repair, in country traffic.

But $4,000 to $6,000 per mile for country roads, according to the cost of crushed stone, is in many cases a prohibitive price; and all the township roads desired can not be built upon the ordinary plans laid down. Certain country roads, with travel enough upon them to warrant improving at all, can be built much cheaper. With the roadbed properly graded, I would apply a 4-in. layer, about 9 ft. wide, of good, hard trap-rock, then cover this layer with dirt obtained along the road and roll it thoroughly. Such a road would only cost about 12 to 20 cents per lin. ft., or say $600 to $1,000 per mile; and it will carry almost any kind of a wagon. But to avoid ruts a wide tire is absolutely essential. I myself use roads a great deal, and in times past my teams were frequently stalled with loads varying from 4,000 to 5,000 lbs. I now use tires 8 ins. wide and haul loads of 6,000 to 8,000 lbs. over the same roads without trouble.

Yours truly, Wm. Haelig.

Bound Brook, N. J., Jan. 20, 1897.

The Anchorage of the Balet Bridge proposed for the St. Lawrence River at Montreal.

Sir: In Engineering News of Jan. 7, 1897, this plan is described and illustrated, with its general dimensions given, and this letter is for the purpose of giving your readers a description of the mode of anchorage of the suspension cables, which is a special feature of the design. The following figures, relating to this anchorage, are copied from the plan which was approved at the meeting of the board of directors of the Montreal Bridge Co., held on Nov. 10, 1896.

The vertical upward pull of the cables is anchored by the anchorage piers at the ends of the bridge. The upward pull of the two cables is 6,670 tons. The reaction from the dead load of the land span, and the adjoining span, plus the weight of the anchor bars, is 1,247 tons; leaving 2,423 tons to be anchored down by the masonry. In the anchorage piers there are 5,356 cu. yds. of masonry, which at 2,025 tons per cu. yd., equals 10,850 tons.

The horizontal pull of the cables is carried along the bottom chord of the landspan to the towers, and is there anchored by the weights of the bridge, the towers, the landspan and the masonry of the piers. The figures in relation to this will be published in a later issue of Engineering News, at the same time with the drawings showing the construction. The depth of foundation for the towers, at the Montreal side, is 25 ft. below water, and at the Ile Ronde side, 16 ft. below water. The total amount of masonry for the bridge is 84,000 cu. yds., and the cost of the bridge complete from end to end, including the four tracks and the deck, is $2,200,000.

The usual method of anchoring the cables is by laying large blocks of masonry at the anchorages and inserting the cables deep down into these. In comparing the two systems of anchorage economical considerations will decide in favor of that here described. The cost of the large blocks of masonry in the one, is to be compared with the additional steel required in the landspan and in the base of the towers in the other. The use of steel shows a great saving over the employment of masonry under the conditions existing at Montreal. The depth of the foundation and the condition of the bottom, however, should always be considered in determining the mode of anchorage. I claim that the new mode of anchorage, when applicable, has great advantages over the old method; for it makes the bridge more rigid against wind pressure, on account of the large mass of steel in the landspans, and it dispenses with extra spans between the towers and the anchorages, as a little additional steel will make the landspan strong enough to carry the live load. It should be kept in mind that the cables strain the chords in an opposite direction to the strains caused by the live and dead loads. This plan also admits of inspection of the anchorages at all times and without any difficulty; it dispenses with the large blocks of masonry, which are in such contrast with the general light appearance of the suspension bridge, and which, where they come in full view, mar the beauty of the bridge.

Yours truly, Joseph W. Balet, C. E.,

261 Broadway, New York, Jan. 19, 1897.

Setting Out Transition Curves.

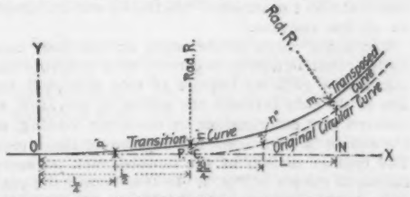
Sir: Many discussions of the transition curve problem have been published in your valuable journal and elsewhere, but I submit the following treatment as being more practicable and much less complicated than any I have seen published.

The circular curve is staked out on the ground in the usual manner, driving a stake at the P. C., and stakes on the tangent at distances $\frac{L}{4}$ and $\frac{L}{2}$, also stakes on the curve at the same distances, measured, in each case, from the P. C. Here L denotes the length of the transition curve, as given in the table. Having these five stakes, the transition is merely a matter of tracklaying, by applying the tabulated offsets for these points, towards the center of curve, as indicated in the diagram. The portion of the circular curve between two successive transition curves, is offset by the constant amount m, given in the table:

Offsets for Staking out Transition Curves from Circular Curves.

		Offsets from Circular Curve.				
	Radius		$X=\frac{L}{4}$	$X=\frac{L}{2}$	$X=\frac{3L}{4}$	$X=L$
Degree of curve.	R	L	p'	n'	n''	m.
	ft.	ft.	ft.	ft.	ft.	ft.
2° 00'.....	2,864.9	60.7	0.003	0.027	0.051	0.054
15'.....	2,546.6	68.3	0.004	0.038	0.071	0.076
30'.....	2,292.0	75.9	0.006	0.052	0.098	0.105
45'.....	2,083.7	83.4	0.008	0.069	0.130	0.139
3° 00'.....	1,910.1	91.0	0.011	0.090	0.176	0.181
15'.....	1,763.2	98.6	0.014	0.115	0.216	0.230
30'.....	1,637.3	106.2	0.018	0.143	0.269	0.287
45'.....	1,528.2	113.7	0.022	0.176	0.330	0.352
4° 00'.....	1,432.7	121.3	0.027	0.214	0.401	0.428
15'.....	1,348.5	128.8	0.032	0.257	0.481	0.513
30'.....	1,273.6	136.4	0.038	0.304	0.570	0.608
45'.....	1,206.6	144.0	0.045	0.358	0.671	0.716
5° 00'.....	1,146.3	151.7	0.052	0.418	0.783	0.836
15'.....	1,091.7	159.3	0.060	0.484	0.907	0.968
30'.....	1,042.1	166.8	0.069	0.556	1.042	1.112
45'.....	996.9	174.4	0.079	0.636	1.191	1.271
6° 00'.....	955.4	181.9	0.090	0.722	1.352	1.443

Should the offsets from other curves be desired, they may be computed from the equations, but it has been found in practice that the information in the table is ample for all curves up to 6°. The tabulated values may, by interpolation, be used for intermediate curves.



The equation of the transition curve referred to axes X Y, with origin at 0 (see figure) is: $Y=\frac{X^3}{6\,L\,R}$, in which L R = 173800, a constant found to give good results in not giving excessive values for the offset m. The length of transition is then $L=\frac{173800}{R}$.

For points between 0 and the P. C. the ordinate from the tangent is $p=\frac{X^3}{6\,L\,R}=\frac{X^3}{1042800}$.

For points between P. C. and N the offset from the circular curve is $n=\frac{X^3}{6\,L\,R}-\frac{(X-L)^2}{2\,R}$.

This value is correct within all practicable limits.

The special values for the points given in the table are obtained by substituting for X in the above equations the values $\frac{L}{4}$, $\frac{L}{2}$, $\frac{3L}{4}$ and L, and getting:

$p'=\frac{L^2}{384\,R}$, $n'=\frac{L^2}{48\,R}$, $n''=\frac{5\,L^2}{128\,R}$ and $m=\frac{L^2}{24\,R}$.

No transition curves are considered necessary for curves flatter than 2°.

The elevation of the outer rail should be uniformly distributed over a distance twice the length of transition curve, attaining its full amount at the end of same, and half this amount at the beginning of the transition curve.

I used this method while engaged on the German Government Railways (Weizen-Immendingen Line), in 1887-1890, and I gave the above notes to the Illinois Central R. R., on which line I believe the method has since been used.

Yours truly,

David Molitor, C. E.

Detroit, Mich., Dec. 19, 1896.

"Flowed Steel" Headers for Water-Tube Boilers.

Sir: It having come to our notice on several occasions recently that some of our competitors in the manufacture of water-tube boilers have been offering to the general public boilers of the Babcock & Wilcox type, the headers or manifolds and crossboxes on which are claimed to be made of "Flowed" steel, we desire to call your attention to the fact that "Flowed" steel is a special mix of open hearth steel manufactured under a secret formula which belongs to us alone, the knowledge of the preparation of which is in the possession of no one except the Penn Steel Casting & Machine Co., of Chester, Pa. As anyone offering either headers, crossboxes or flanges made of "Flowed" steel is doing so with intent to deceive the public, we wish that you would publish in your paper the foregoing statement, and in addition the following letter written by the Penn Steel Casting & Machine Co. to our General Eastern Agents.

Very truly yours,

Cahall Sales Dept.,

W. C. Temple, Genl. Manager.

Bank of Commerce Building, Pittsburg, Pa., Jan. 22, 1897.

The letter enclosed is as follows:

Office of Penn Steel Casting & Machine Co.,
Chester, Pa., Jan. 21, 1897.

Messrs. Thayer & Co., Inc., Drexel Bldg., Philadelphia.

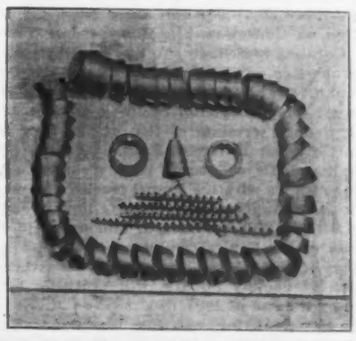
Gentlemen: Referring to your inquiry of even date, we beg to state that we consider the special mixture for flowed steel, we are making for you, your property, of which you have the sole right, and that we never have nor never will furnish flowed steel to anyone but yourselves unless authorized by you. Neither will we give to anyone any information as to the formula under which this special mixture is made.

Yours respectfully,

Penn Steel Casting & Machine Co.,

Fred. Baldt, Manager.

(In answer to our request that the Cahall Sales Department would furnish us some additional information concerning the nature and qualities of this material, called "Flowed" steel, Mr. Temple sends us the photograph, which we here reproduce, showing some borings and turnings made from the metal, and a box containing a long turn-



Some Shavings Turned from "Flowed" Steel Headers for Steam Boilers.

Made by the Penn Steel Casting & Machine Co. for the Aultman & Taylor Machinery Co., Manufacturers of Water Tube Boilers.

ing similar to the one shown in the photograph. It is to all appearances as tough and elastic as a turning from a forged steel gun. He informs us that the makers guarantee that castings made by them from this steel will show in a test piece 8 ins. long an elongation not less than 25% and a reduction of area of not less than 50%. In actual tests they generally run 28 or 29% elongation and 55 to 58% reduction and as high as 31% elongation and over 60% reduction has been obtained. The basis of the mixture from which the material is made is open hearth steel. It contains both nickel and aluminum, with other materials as alloys, but the proportions of these are kept secret.—Ed.)

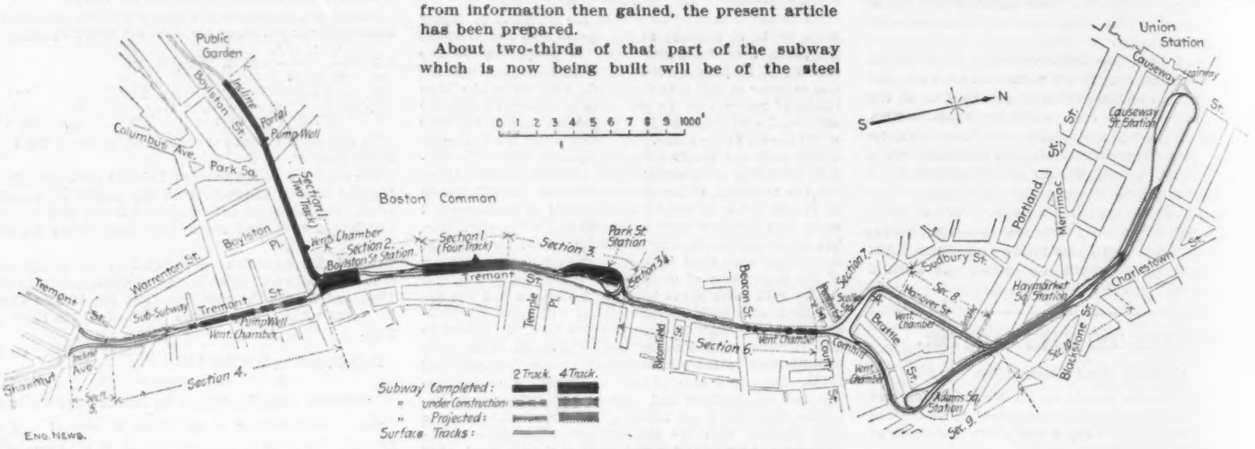


FIG. 1.—PROGRESS PLAN OF THE BOSTON SUBWAY.

PROGRESS OF THE BOSTON SUBWAY.

Work is progressing satisfactorily on the subway or tunnel at Boston, Mass., which is being built to relieve the traffic in the congested district of the city. The general purpose and plan of this subway is probably familiar to most of our readers, as we have fully described it in former issues, so it will be sufficient to explain here that the subway is for the use of the electric cars which now run on the street surface, thus leaving the narrow streets free for the heavy vehicle traffic upon them. So many of the electric car lines converge upon Tremont St. that at present there is almost a continuous line of cars during the busy hours, causing much inconvenience, delay and danger to the regular street traffic.

The city undertook the construction of this subway, and in December, 1896, it was leased to the West End Street Ry. Co., which controls practically all the electric lines of Boston and vicinity.

The complete scheme is for a tunnel (partly two-track and partly four-track, see Engineering News, May 30, 1895) extending from the Union station on Causeway St., along under Haverhill St., Cornhill and Tremont Sts. to Boylston St.; here one line will continue on to the junction of Tremont St. and Shawmut Ave., and another will turn off along Boylston St. to a point near the Park Square terminal station of the New York, New Haven & Hartford R. R. At each of the three terminals will be an incline connecting the surface tracks with the tunnel tracks. At present work is in progress from Scollay Square (at the head of Cornhill) southward, and a considerable section of the line is completed, so that all this portion of the scheme, including a loop terminal station at Scollay Square, will probably be finished by the end of 1897.

The accompanying map, Fig. 1, reproduced from the annual report made by Mr. Howard A. Carson, M. Am. Soc. C. E., Chief Engineer to the Boston Transit Commission, shows the condition of work up to Aug. 15, 1896, but considerable progress has been made since that date, though the Commission has only recently issued the report. The Boylston St. line and approach are completed, the Shawmut Ave. approach is being built, and the line under the Common is practically completed, while work on the other parts now under construction is being actively prosecuted. The inclined approaches have concrete walls faced with granite, and at the Shawmut Ave. approach (which occupies a triangular space at the junction of Shawmut Ave. and Tremont St.) foundations have been put in for a ten-story building over the incline, should the city decide to have such a structure erected in the future.

During a recent visit to Boston a member of the staff of this journal made a personal examination of this interesting work with Mr. Carson, and from information then gained, the present article has been prepared.

About two-thirds of that part of the subway which is now being built will be of the steel and concrete construction described and illustrated in our issue of May 30, 1894. In this system there are steel columns resting on a concrete invert and carrying steel roof beams, concrete side walls being built flush with the columns (and recessed between them), and brick arches being built between the roof beams. Most of this work has been done in open cut, partly under streets, but mainly under the edge of the Common and the Public Gardens, where little interference with traffic was caused. At the north end of the Common, where the narrow part of Tremont St. commences, there is a large surface excavation on the site of one of the stations. Around this the electric cars are run on a temporary track across the corner of the Common, leaving the other side free for street traffic. On this open cut work, all the material is handled by derricks with long booms, operated by steam hoisting engines. The earth is removed by buckets, which are dumped into wagons, the spoil being deposited upon the Common in banks. Most of this excavated material is used for raising the grade of low sections of the Common, part is washed and used for filling behind the side walls, and the balance is now being carted away, some of it being used for filling at the site of the new Southern terminal station (Eng. News, Jan. 14, 1897). The derricks also handle the stone, ironwork, etc., which are hauled by teams to the site of the excavation. The material is mainly gravel, which stands well, and is held up by sheet piling, well braced. In the completed sections the ironwork is painted with red lead, and various styles of treatment of the concrete side walls have been tried on individual panels, at the expense of the inventors or manufacturers. These include enamel paints, whitewashes, plaster on expanded metal, glazed bricks, and marble slabs, the latter being very effective and even cheaper than the brick. Between the stations the concrete may be left with its natural surface and color, or may be simply whitewashed, but a more elaborate and decorative treatment will be adopted at the stations.

The other third of the work on the part now under construction is in tunnel, with concrete lining, and a peculiar feature of this system is the use of tie rods through the crown of the arch, to prevent any deformation by eccentric loading, as the crown is very near the surface of the street. The typical section of the double-track masonry tunnel in shown in Fig. 2. In this system the concrete side walls are double. First there is a rough outer wall 6 to 12 ins. thick, backed directly against the sides of the excavation, and this is plastered with an asphalt composition. Then the regular inner wall is built against this, the concrete being rammed down between the outer wall and the vertical molds for the tunnel face, these molds being usually braced against the unremoved earth core of the tunnel. At some parts, steel columns are embedded in the walls, and have their tops connected by transverse tie-rods. In such cases a double wall of hollow tile is built between the two concrete walls, and the bottom of this connects with 2-in. lateral pipe drains opening out on the surface of the invert, the water being carried into the central drain. Similar drains are also used in the steel and concrete covered way, the drains being of 2-in. vitrified pipe. The tie-rods are attached to stirrups embracing the top of the columns. Where steel columns are not used, the haunches of the crown are formed with vertical faces to give a seat for the anchor plates of the tie-rods. The rods are sometimes in one length, screwed into the stirrups by means of 36-in. wrenches, while at other places they are in two lengths, with the inner ends connected by a turnbuckle. On double track, the tie-rods come below the inside surface of the arch, but in single track (where one track passes under another to avoid a grade crossing) they are entirely within the thickness of the arch. The tunnels have an ample cross-sectional area, but refuges for trackmen are formed, nevertheless, close together along the entire length of the concrete walls.

Under the narrow and busy section of Tremont St. between the Common and Scollay Square, the work of tunneling is being done by the city, by day labor, as the contractor did not make satisfactory progress under the difficult conditions of prosecuting the work. No interference with the traffic is allowed here, and the only openings allowed are small ones 6 × 4 ft., at the curb line. Two methods of construction are being practiced here: 1, By "slicing;" 2, By tunneling. In the former case a shaft is sunk at the side of the street (the street surface being of plank bridging) and a cut 12 ft. wide is made across the entire width of the street. The side walls and arch are then put in, and the back filling is done, making a finished section of the tunnel 12 ft. long. Various sections are built in this way, and then the sections between them are built.

In the second case, two side tunnels are driven, and in these are built the side walls. The arch is then built, part of the core being left to be removed by end excavation in the tunnel at a later time. A hydraulic shield having an exterior diameter of 29 ft. 4 ins. is used for driving the excavation for the arch. This shield, which is of peculiar construction, has a diameter nearly 2 ft. greater than that of the Blackwall tunnel under the Thames at London (Eng. News, Aug. 22, 1895).

The material met with on the work has been mainly gravel, conveying very little water. There has been but one cave-in, and that was not of serious moment. On this work the men work in two shifts of ten hours each, leaving four hours for cleaning up, etc. A greater number of men are employed on the night shifts, as no wagons may

deliver or remove material at the shaft openings until after 7 p. m.

Special methods were required for handling the excavated material. Fig. 3 shows the dumping incline used for handling earth from "slice" excavations at the junction of Shawmut Ave. and Tremont St. The tubs of earth were hoisted and run out on the incline, and then dumped directly into the wagons. Fig. 4 shows one of the conveyors used on the narrow part of Tremont St. The tubs

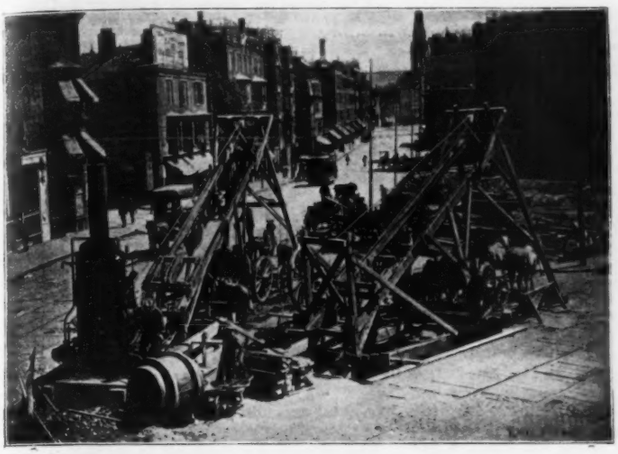


FIG. 3.—DUMPING INCLINES FOR LOADING CARTS AT EXCAVATION.

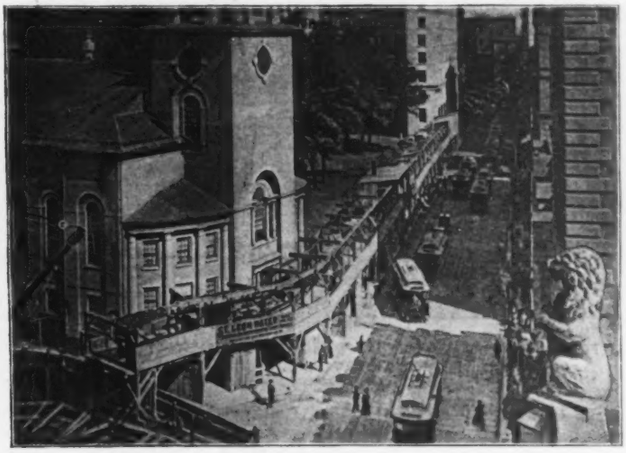


FIG. 4.—VIEW OF CONVEYOR OVER SIDEWALK ON TREMONT STREET.

are hoisted up an enclosed shaft to a conveyor carried over the sidewalk, a closely boarded platform being built over the sidewalk to prevent any dirt falling upon pedestrians.

The specifications for Section No. 2, which is almost entirely under the edge of the Boston Common, were published in our issue of Oct. 24, 1895, giving the clauses governing the opening of the street surface and the interference with traffic. Of more importance in these latter respects is the work under the narrow streets, and we give below an extract from the specifications for Section No. 6, which includes the work under Tremont St. from Park St. to near Scollay Square.

About 24 ft. in length of the northerly end of the contract section, and about 130 ft. at the southerly end may be done by the method of cut and cover excavation, and the central portion between these ends shall be done (except as hereinafter provided) by some method of tunneling.

So much of the subway construction as is not done in tunnel shall be carried on as follows, or by some other plan approved by the engineer:

Trenches about 12 ft. wide shall be excavated across the street to as great a distance and depth as is necessary for the construction of the subway. The top of this excavation shall be bridged by strong beams and timbering, whose upper surface is flush with the surface of the street. These beams shall be used to support the railway tracks as well as the ordinary traffic. Portions of the bridging can be removed during the night in accordance with the provisions of this article. In each trench a portion (which may be called a slice) of the subway shall be constructed. Each slice of the subway thus built is to be properly joined in due time to the contiguous slices. The contractor shall have as many trenches in process of excavation, in process of being filled with masonry, and in process of being backfilled with earth above completed masonry, as is necessary for the even and steady progress of the work towards completion in connection with the tunnel work, at the time named in this contract. Whatever plan the contractor makes use of in any part of the work under this contract shall not relieve him of any of his responsibilities under this contract.

The operations of constructing the subway shall be carried on during the night, and also in the day as far as is consistent with the provisions of this contract. The contractor shall so conduct all his operations as to interfere as little as is practicable with the normal use of the streets.

If the engineer finds that satisfactory electrical hoisting apparatus can be readily obtained he may require its use.

The contractor shall by supports and bridging, and by other suitable means, maintain the surface of the sidewalks and street, including the railway tracks (co-operating with the officers of the railway for this purpose), all in an entirely safe condition for their usual service as follows:

Week Days.

(1.) From 7 a. m. to 7 p. m.: The whole surface (except areas for shafts) of Tremont St., of all side streets, and of all sidewalks; all tracks open for the passage of street cars.

(2.) From 7 p. m. to 11.30 p. m.: One-third of the width of Tremont St. between curbs, and also of all side streets (making five-ninths of the area at junction with side streets), one-half of the width of each sidewalk, and opposite crosswalks the whole width; north bound track for entire length of section, and south bound tracks south from Bromfield St., open for the passage of street cars.

(3.) From 11.30 p. m. to 6 a. m.: Same as to street and sidewalk surface as in (2); no tracks need be in service.

(4.) From 6 a. m. to 7 a. m.: Same as to street and sidewalk surface as in (2) and (3); all tracks open for the passage of street cars.

Sundays.

(5.) From midnight Saturday to midnight Sunday: Same as to street and sidewalk surface and as to tracks as in (3).

The space left unoccupied must be such that at any time fire-engines can pass through Tremont St. and into any side street.

The contractor shall be debited 1 ct. per day of twelve hours for each square foot of surface that he occupies (or by his act or neglect leaves unavailable for public use) between the hours of 7 a. m. and 7 p. m. in accordance with the provisions of this contract, and a proportionate sum for any less time. If he occupies surface in violation of the provisions of this contract, he shall be debited at the rate of 6 cts. per sq. ft. per day of 24 hours, and a proportionate sum for any less time. The sums so debited may be deducted from any moneys which become due the contractor on account of this contract.

The tendency of contractors to occupy a large space for their tools and material is checked by the latter clause of the extract quoted above, which is termed a clause of "debit for street occupancy."

At two of the openings on Tremont St., a Carson overhead conveyor is used to haul away the excavated material. A substantial roof or platform is built over the sidewalk, and above this is the conveyor rail. One opening is at the corner of the Common, opposite Park St. church, and the conveyor runs north along Tremont St., above the sidewalk, turning off to a side street where carts can stand to receive the material. This conveyor, with the platform covering the sidewalk, is shown in Fig. 4. The other opening is on the east side of the street, opposite the churchyard of Kings Chapel, and the conveyor runs over the sidewalk and across the churchyard to a court where the carts come. The tunnel work is carried on mainly by the light of gasoline torches, but incandescent electric lights are used in the side tunnels on the Tremont St. work.

The concrete is tested by breaking concrete beams 6 × 6 × 72 ins. in a testing machine. In a number of tests, concrete made with broken brick has shown the best results, that made with clean pebbles coming second, and that made with broken stone coming last.

It is very generally assumed that broken stone is the best material for concrete, but it may be noted here that for the monolithic concrete foundations for St. John's Cathedral, New York city,

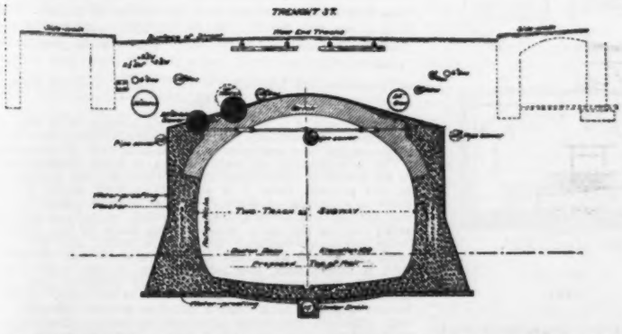


FIG. 2.—TYPICAL SECTION OF DOUBLE TRACK MASONRY TUNNEL; BOSTON SUBWAY.

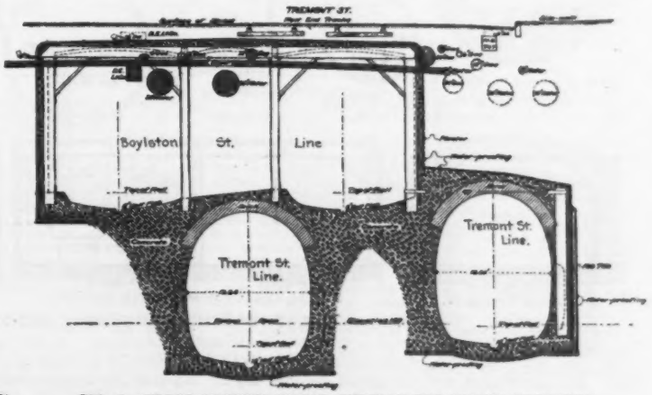


FIG. 6.—CROSS-SECTION OF SUB-SUBWAY FOR TRACK CROSSING.

clean round pebbles were adopted after numerous tests as to the comparative merits of such pebbles and broken stone.

The maximum grade downward in the subway is one of 8%, but there are several of 5%. At junctions and loops all grade crossings are avoided by means of lowering the grade of one track by what is termed a sub-subway.

In the report of the Boston Transit Commission for the year ending Aug. 15, 1896, which has been already mentioned, it is stated that although the work is novel in method and character, no serious unexpected difficulties have been met with, and though several of the contractors failed to complete their portions of the work within the contract time, these delays will not materially

9,498 ft., or 1.8 miles, and this will include two, three and four-track sections, the total length of single track being 5.3 miles. The excavation of the subway was commenced on March 28, 1895, and up to Aug. 15, 1896, work was completed or under contract for 2.94 miles of single track, or 55.4% of the total, and, as already noted, considerable progress has been made since that date.

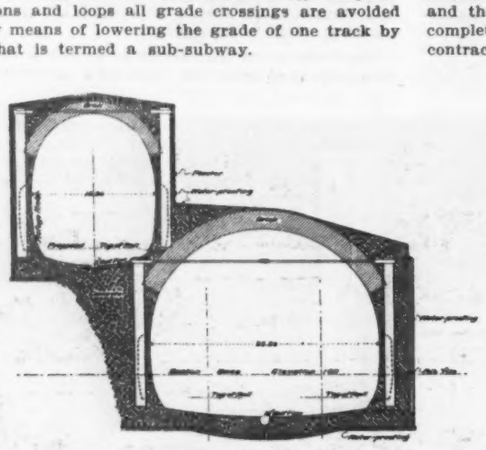


FIG. 8.—CROSS-SECTION OF APPROACH TO SUB-SUBWAY FOR TRACK CROSSING.

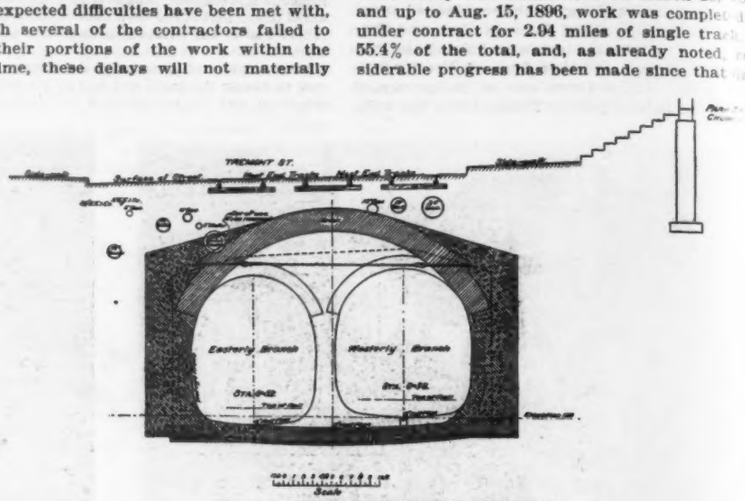


FIG. 7.—SECTION OF BELLMOUTH TUNNEL.

Some typical cross-sections of the "sub-subway" crossing at the junction of the lines on Boylston and on Tremont St. south of Boylston St. are shown in Figs. 5 and 6. Both of these are double-track lines, and form a four-track line north of the junction, but the grade of the latter falls below that of the former. Fig. 5 is a section just south of the station, and Fig. 6 shows the two single-track tunnels, which unite to form a double-track tunnel further south on Tremont St. Fig. 7 is a section of the bell-mouth of the masonry tunnel on Tremont St., opposite Park St.

There will be three intermediate stations south of Scollay Square, with entrances by stairs at openings on the Common. The stations will have separate platforms for northbound and southbound cars, with subways under the tracks, connecting

postpone the completion of the whole work. In 1896 an act was passed limiting the term of contract between the commission and any street railway company (for the use of the subway) to 20 years, instead of 50 years, as in the former act. A proposition was made to prohibit a contract for the exclusive use of the subway by any one company, but this did not become a law. A slight change has been made in the route, by which the two southbound tracks to Scollay Square will be under Hanover St. instead of Brattle St. This route conforms more closely to that of the present surface routes and will give better accommodation. The depth of the subway platforms below the street is too small to render the use of elevators desirable, but moving inclines are being considered as adjuncts to the stairways. Fig.

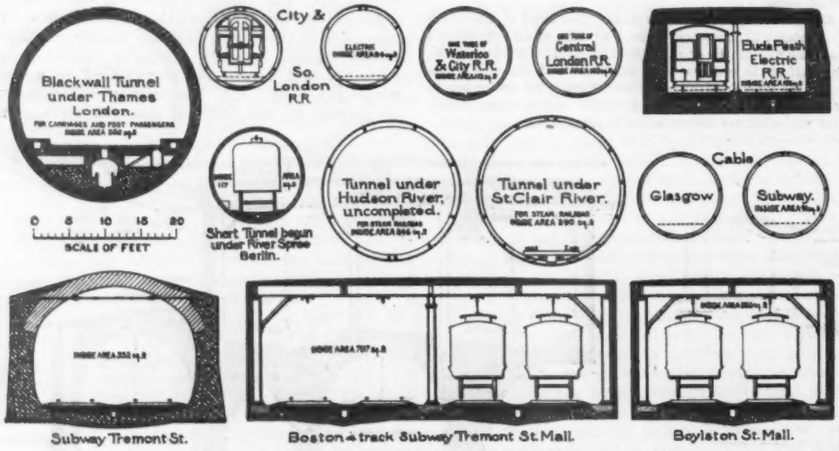


FIG. 8.—COMPARATIVE SECTIONS OF VARIOUS SUBWAYS.

these platforms, which are placed nearly end to end. The platforms will be about 10 ins. high above the rail heads, or about level with the lowest step of a street car. The company leasing the tunnel will build its own track. It may be of rails or timber longitudinals resting upon the concrete floor of the invert, or it may be an ordinary type of railway track with ties laid in broken stone ballast, the central drain being surrounded by dry brick walls with flagstone covering.

A pumping station with an electric pump of 600 gallons capacity per minute will take care of the drainage, and there will be eight ventilating fan chambers, all formed of monolithic concrete, the shaping of the molds or forms being somewhat complicated.

8, reproduced from a plate in this report, gives an interesting comparison of several underground railways.

The report of Mr. Howard A. Carson, M. Am. Soc. C. E., Chief Engineer, is a most interesting document, describing in detail the methods of work and the progress made in the various sections; and also describing some subway work in foreign cities. This report is illustrated by numerous views reproduced from photographs, and also by plans of the stations, etc., and diagrams showing the various arrangement of tracks proposed for the loop and other stations. To the report are appended the tabulated bids on the subway work now under contract. The total length of the subway will be

The total expenditure to Aug. 15, 1896, amounted to $1,703,772.

The underground railway or subway is not the only work of the Transit Commission, but the new Charles River bridge is also entrusted to it. Plans for this bridge were prepared by Mr. Wm. Jackson, M. Am. Soc. C. E., City Engineer, and the contract for the piers and foundations was let July 20, 1896. It is expected that the piers will be ready for the superstructure by the autumn of 1897. In November, 1895, the City Council requested the commission to proceed with the construction of a tunnel between Boston and East Boston. An estimate made by Mr. Carson showed that the cost would be about $2,400,000, and as the appropriation for the construction of subways is only $7,000,000, the commission concluded that this sum would not be sufficient to build both the subway now under construction and the tunnel. No further steps have therefore been taken for the latter work.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

In last week's issue we gave a report of the first two sessions of this meeting, held on Tuesday, Jan. 26. The third session was held on Wednesday afternoon, and was devoted to reading and discussion of papers. The first paper was by Mr. W. M. Mackay, manager of the Hart & Crounse Co., New York. We give an abstract of it below.

Arrangement of Mains in a Hot Water Heating Apparatus.

The success of a hot water heating apparatus is largely dependent on and effected by the arrangement, size and grade of the flow and return mains and their connections.

The arrangement of mains which is most largely used in an ordinary installation of hot water heating apparatus at the present time is a number of flow mains rising from the source of supply to the farthest point to be reached, with a corresponding number of returns of the same size on the same grade falling back to the heater. Some engineers contend that this is wrong and that the radiation would be better and more uniformly supplied with a single flow and return main in the same way, but this statement should always be qualified and the existing conditions considered before it is made. If the heater is placed at a central point to supply radiation in four different directions it would be better supplied by four separate flow and return mains from the heater than by a single main. When the radiation is located in one direction from the heater it is often possible and practical to supply it with a single main, but there is a limit in size or diameter beyond which it is not safe or wise to go, and after reaching this limit it is an advantage to use two or more mains rather than to increase the size of a single main. While larger mains have been used and recommended, I have always found it best to place the limit at from eight to ten inches diameter, depending on the conditions; my objection to a larger main being the large body of water it contains, the difference in temperature between the top and bottom of the main causing unequal expansion, and the possibility of an internal circulation interfering with the general of desired circulation.

I have in mind a large building which was heated by hot water some years ago; in one section of it, about 60 × 40 ft., the main was carried from the heaters to the outside wall and continuously around it back to within 20 ft. of the heaters, making this single main about 180

ft. long. The circulation in this main has never been uniform and with a low temperature of water the far end of it for about 50 or 90 ft. is almost cold, whereas if two mains of a smaller size had been used each of them would have been 90 ft. long and they would have given an apparently uniform circulation. While it is claimed that it is impossible to hold cold water above hot water in a hot water system it is possible in this case and in any case where, on account of a large main and a free circulation through the radiators and risers near the heater, the water is allowed to enter the return main near the heater at, say, five to ten degrees lower than the temperature of the flow main; the natural tendency of this heated water in the return main is to travel toward the upper end of the main instead if returning to the heater. Under these conditions, as soon as a sufficient number of radiators and connections are circulated to relieve the heater at the temperature at which it may be operated, the two columns of water at about the same temperature traveling or attempting to travel in the same direction hold the balance of the system in check and keep it cold. As it is often necessary to arrange mains in this way and sometimes impossible to arrange them in any other way it is very desirable that there should be a remedy for this trouble, and I have found that the best and surest preventive was to take the connections for the near radiators, or for all the radiators and connections, from the side instead of from the top of the flow and return mains, thus retarding the flow through the near connections, assisting the flow to the extreme end, and making a uniform circulation through the entire main and system.

I designed an apparatus in this way some time ago where the main was over 300 ft. long, and with the water at the heater at 130° F. the temperature of the water at the extreme end was 120°, while with a higher temperature of water at the heater the difference was less, until at 180° the difference was only 5°. I mention this to show that with a proper arrangement of branch connections and a suitable size of main it is possible to circulate water through a continuously rising horizontal main for long distances at a comparatively uniform temperature.

Some engineers have recommended a continuous circulating main rising to the highest point immediately above the heater and falling around the basement, usually near the outside walls and connecting with the return opening of the heater, the branch flow connections being taken from the top of this main and the return connections being taken into the side of the same main, this arrangement possibly being suggested by the continuous circulation in a one-pipe steam system which it resembles. The objection to this system in hot water heating is that while in steam above atmospheric pressure there is uniform distribution and temperature, in a hot water system, the circulation being dependent on a loss of temperature which in actual practice varies from 10° to 40° and which is usually over 20°, radiation figured at a uniform ratio for cubical contents, wall, and glass exposure, will heat to different temperatures at different points in the main, making it necessary to plan the arrangement of the main before proportioning the radiating surface, any change in the main affecting the temperature of the service.

The overhead system, where practical or permissible, has some advantages, doing away with separate return risers and permitting the use of a smaller area of main for a given amount of radiation, and while the temperature of the water on the lower floors with this system is lower than on those above, radiation can be figured uniformly on any floor with a certainty of a uniform temperature and a positive knowledge as to results.

I have found the proper average proportion of area in mains for the ordinary rising main system to be 1 sq. in. in area for each 100 sq. ft. of radiation and for the overhead system, 25% less, increasing the area in either case in long runs to overcome friction and to insure a uniform circulation.

The discussion, as usual, was not confined to the subject of the paper, and it led to the expression of a diversity of opinion as to the causes of the circulation in a hot water system. Some of the members thought that the mere difference in temperature of the water in the rising and the return mains was not sufficient to account for the flow, and their theory was that the expansion due to the formation of small bubbles of steam in the boiler acted to push the water along. They did not attempt to explain how such steam could be formed in water under a pressure due to the level of the expansion tank while its temperature was below 212°, nor how such expansion would not tend to oppose the flow in the return main. The fact is that the art of hot water heating has been developed through years of experience by men who use "rule of thumb," and while these men can design good heating systems their theories given to explain the reasons of the actions of the systems are not such as would be accepted by students of physics.

The next paper was by Prof. R. C. Carpenter, the President of the Society, and was entitled "Relative Efficiency of Ventilation by a Chimney and by a Fan." This paper showed, by mathematical calculation, that when artificial ventilation is required, it is much more economical of fuel to obtain it by means of a fan, notwithstanding the fact that both the fan and the engine driving it are notoriously wasteful instruments, than to obtain it by heating a chimney. The efficiency of a chimney considered as a heat engine is expressed by the formula $E = h \div 96304$, in which h is the height of the chimney in feet. The reason that a chimney is so very inefficient is of course the fact that nearly all the heat put into it at the base is discharged out of the top, while in an engine 10%, more or less, of the heat put into it is converted into work. With fans and engines of average quality, a fan is at least ten times as efficient as a chimney under ordinary conditions of temperature, and this superiority is increased as the temperature of the chimney increases.

The discussion brought out the fact that while chimneys are very inefficient means of ventilation considered from the standpoint of fuel economy, their use is advisable whenever the heat used in them is heat which would otherwise be wasted.

One of the "topical questions" was next taken up, viz.: "What is the highest temperature that can be maintained in a hot air furnace without detriment to the air passing through it." The discussion covered a wide range, including the effects of leakage of the furnace gases from the fire box, the passage of the gases through the cast iron, the burning of fine particles of dust containing organic matter which are in the air or on the flues, etc., but no one was able to give a direct answer to the question.

The evening's session was devoted chiefly to reading and discussion of a paper by Mr. Reginald Pelham Bolton, entitled:

"Circulation of Steam for Heating Purposes at or Below the Pressure of the Atmosphere."

The object of the paper was chiefly to call attention to the advantages of the Webster combination system of steam heating, which was illustrated in several forms. The following is a brief abstract of the descriptive portion of the paper:

Primary requirements for effective steam heating systems are: 1. Absence of back pressure on motive engines where exhaust steam can be utilized. 2. Efficiency of drainage of supply pipe system preliminary to drainage of the radiating surface. 3. Continuous automatic drainage of condensation. 4. Effectiveness of circulation. 5. Control, or variability at will, of circulation. 6. Removal of air and gases from heat surfaces and from feed water. 7. Regulation of temperature in any part of heating surface. 8. Return of water from some moderate distance below the line of drip or drainage, if necessary.

Apparatus which does not demonstrate its capability of compliance with all these conditions, must by the heating engineer be considered incomplete.

The above requirements are not fulfilled by any system employing one pipe for supply and return, nor by any system removing only the air-gases and not dealing with equal certainty with the water of condensation, nor by any arrangement establishing a partial suction in a coil or radiator in such a way as to act in opposition to the free drainage of the condensation, nor by any apparatus requiring more than one hand-valve for regulation by unskilled persons of a coil or radiator, nor by any system incapable of lifting the drainage from a point somewhat lower than that of outlet or of final disposition.

On the other hand, the whole of these have been found in the author's practice to be complied with by an apparatus known as the Webster combination system. It comprises primarily an automatic outlet valve to each part requiring drainage, a connection of it to a suction apparatus, such as a pump or an ejector, the abstraction of all air and gases from the heating system, and the return of the condensed water into a heater wherein the water and gases freely disassociate in a chamber sealed from the atmosphere, and where the temperature of the condensed water, plus that of any additional fresh supply found to be necessary, is raised by direct contact with a proportional amount of exhaust or waste steam, and finally the return of the whole automatically to the boiler.

The operation of this apparatus can be brought to any degree of automatic regulation, its control is entirely in the engineer's or fireman's discretion, while leaving the control of each individual radiator or coil absolutely in the hands of the tenant or occupant, by means of one hand-valve only.

A remarkable result due to this arrangement is the ability to reduce the total temperature of any separate coil or radiator by reducing the amount of steam admitted to it, without water logging or hammering. This is done at will by closing down on the inlet supply to the desired degree. The result is the admission of a smaller amount of steam to the coil than it is calculated to condense normally.

Preceding the description of the system the author gives several pages of theories concerning the action of the vacuum system of steam heating, some of which are remarkable for originality, if not for accuracy. The following extracts give a general idea of the character of his argument:

A study of the figures of the flow of liquids in standard pipes will demonstrate that the advantage in ease of flow of steam is on the side of a low pressure system into a partial vacuum as against one pressure of steam into another.

Where the object to be attained is the abstraction of heat from a gas the more free and expanded the volume is, with corresponding freedom of renewal of the heating element, the better the result. A cramped and confined volume containing heat, even at a higher temperature, does not part with heat as readily as the same amount comparatively expanded and allowed to continually impinge fresh quantities as heat is removed.

The presence of air-gases in the feed water and in the boiler is, in reality, a factor affecting a much larger percentage of economy, yet is one of which little notice is commonly taken. All fresh water is more or less aerated, a condition which causes losses in heat in the boiler greatly out of proportion to its amount. Much of the waste heat of combustion in boilers is due to the energy wastefully expended in heating up the air and gases contained in the water, and any direct saving of fuel in that direction can thus be credited to a system of removal of air-gases from the feed.

As might be expected the paper was subjected to severe criticism. Mr. H. J. Barron read a carefully prepared attack upon it, and several other members also expressed their disapproval. The vacuum system itself was highly commended by some of the speakers, however, and the attacks on the paper were not so much objections to the system as to the method the author adopted in treating of it. The treatment this paper received would have given offence to some authors, but Mr. Bolton took it all in good part, and closed the discussion with some very pleasant remarks well calculated to put his audience in sympathy with him.

Thursday morning's session was devoted chiefly to business of the society. The committee on legislation reported in favor of trying to secure compulsory laws in the several states providing for the efficient ventilation of school and other public buildings, for the appointment of inspectors of ventilation, etc. After some discussion the report was approved and the committee continued.

The officers of the society for the ensuing year are as follows: President, W. M. Mackay, New York; Vice Presidents, H. D. Crane, Cincinnati; Henry Adams, Washington, D. C.; A. E. Kenrick, Brookline, Mass.; Secretary (office vacant on account of the death of Mr. L. H. Hart. The vacancy will be filled by the board of managers); Treasurer, J. A. Goodrich, New York; Board of Managers, R. C. Carpenter, Ithaca, N. Y.; S. A. Jellett, Philadelphia; W. F. Wolfe, Boston; W S. Hadaway, New York; E. P. Bates, Syracuse; Council, A. A. Cryer, Wm. McMannis and B. F. Shaugland, New York; James Mackay, Chicago; John A. Fish, Boston.

At the final session, on Thursday afternoon, a paper was presented by the council entitled,

"Comparative Test of Two Centrifugal Fans."

It contained an account of a series of tests made by Prof. J. E. Denton, of the Stevens Institute of Technology, of two fans constructed on different principles, and the council presented the paper for the purpose of inviting discussion. The dimensions of the two fans were as follows:

	A.		B.	
Outside diameter of wheel	36	in.	31	in.
Inside " " "	15	"	15	"
Width of wheel at outside diameter.	6	"	1¾	"
Width of wheel at inside diameter...	6	"	5½	"
Diameter of inlet on each side of fan.	15	"	15	"
Diameter of outlet	12	"	12	"
Height of case	52	"	52	"
Width over outside of shaft bearings.	38	"	38	"
Diameter of shaft	1½	"	1⅝	"
Diameter of pulleys (2)	8	"	8	"
Number of main blades	8	"	6	"
Number of intermediate blades	0	"	18	"

Fan A had curved blades which were provided with side sheathings. Fan B had radial blades, the main blades being of full length and the intermediate blades of about half the length of the main blades. The results of the tests are given in the accompanying table:

Results of Experiments on Blowers.

1. Blower.	2. Area, smallest opening, sq. ins.	3. Revolutions per minute.	4. Press. in blower case at section of pipe of 0.64 sq. ft., ozs.	5. Sum press. and head due velocity, ozs.	6. Air per min., cu. ft.	7. Indicated HP.	8. Cu. ft. per HP.	9. Proportion theoretical pressure realized.
A	....71.00[2]	1,480	2.2	6.38	6,520	16.92	385.3	0.152
B	....71.00[2]	1,900	2.2	6.38	6,520	21.69	300.6	0.131
A	....56.75[3]	1,411	2.8	5.50	5,365	12.32	435.5	0.212
B	....56.75[3]	1,771	1.9	5.43	6,155	17.06	360.8	0.132
A	....56.75[3]	1,333	3.48	5.37	4,576	8.67	527.8	0.292
B	....56.75[3]	1,644	3.35	5.38	4,604	11.34	411.3	0.262
A	....24.50[3]	1,500	7.13	8.29	3,495	11.23	311.2	0.473
B	....24.50[3]	1,846	6.96	8.06	3,407	11.69	291.4	0.444
A	....24.50[3]	1,846	13.59	14.50	3,146	19.57	160.8	0.601
B	....24.50[3]	2,462	13.59	14.50	3,144	22.04	142.6	0.478
A	....24.50[3]	1,500	7.87	8.85	2,483	8.37	296.4	0.531
B	....24.50[3]	1,811	7.56	9.15	2,469	9.07	272.2	0.495

Average temperature of air, 81° F. [1]Connected to 36-in. tube open at atmosphere.
[2]Open to atmosphere at this area through 3° conical tube.
[3]Open to atmosphere at this area through 1½° conical tube.

The revolutions of the engine were recorded by a continuous counter attached to its main shaft. The revolutions of the blower were determined by a worm wheel attached to the shaft of the blower and geared to a gas meter index plate.

The relative economy of the two blowers producing the same pressure (col. 4) is shown by comparison of the figures in column 8 for each pair of experiments. For example, the highest pressure common in cupola practice (tests No. 9 and 10) the air delivered per horse power is 13% greater for blower A than for blower B.

The ninth column shows the proportion which the pressure realized (col. 4) bears to the pressure which might be produced if all of the air passing through the blower was given a rotary velocity equal to the speed of the outer diameter of the wheel.

For tests 9 and 10 the figures in column 9 show that blower A utilizes, in producing pressure, 25% more of the velocity of the tips of its blades than blower B.

The general conclusions to be drawn from the experiments are: First, that for pressures varying from 2 to 14 ounces, and quantities of air varying from 2,500 to 6,500 cu. ft. per minute blower A delivers from 7 to 28% more air per HP. than blower B.

Second, that over the same range of pressures and volumes, blower A utilizes, in producing pressure, from 6 to 60% more velocity of its blades than blower B.

The discussion, which was quite extended, failed to throw any light upon the question of what is the best shape of blades of centrifugal fans, but it showed a general agreement of opinion that the statements made in manufacturers' catalogues concerning the capacity of their fans and the power required to drive them were far from the truth, the error being 50% or more. It is evident that there is great need for more experiments on such fans, and for the publication of correct data concerning them.

"Topical questions" were discussed during the remainder of the session, but little information of value was elicited by them. It was apparent that it is much easier to ask questions relating to the many problems presented on

heating and ventilation than it is to answer them. Such questions, however, stimulate thought among the members, and enlarge their views as to the extent of their ignorance concerning some scientific problems, which is the first step toward scientific study.

"Methods of Proportioning Direct Radiation" was the title of a paper presented by Prof. R. C. Carpenter at the first session, as noted in our issue last week. We give below a brief extract which shows his method. The paper itself gives the data from which the formula is derived, and also the results of some experiments which confirm its approximate accuracy within the limits of the tests.

In addition to the heat which is constantly passing from a building through the walls and windows, a considerable amount must be used to warm the air which enters, and this latter may be considered as a function of the cubic contents of the room.

From my own observations in the heating of residences (direct radiation) I am satisfied it is safe to assume that the air of the principal living rooms will change twice per hour, that the air of halls will change three times per hour, and that the air in the other rooms will change once per hour under ordinary conditions, and that since one heat unit will warm 55 cu. ft. of air under usual conditions 1°, we shall need to supply from 1-55 to 3-55 of the cubic contents in heat units per hour. This gives us, then, a very simple expression for the heat required in B. T. U. per hour for 1° difference of temperature. Take W as the wall surface in square feet, G the area of glass or window surface, C the cubic contents in cubic feet, n the number of times the air must be changed per hour, and h the total heat in heat units for 1° difference of temperature between the room and the surrounding space.

$$h = \left\{ \frac{n}{55} C + G + \tfrac{1}{4} W \right\}$$

For the ordinary conditions of heating we are usually required to proportion the radiation so as to maintain the temperature at 70° when the outside temperature is zero and, furthermore, all the portions of the house are kept so nearly at the same temperature that it is perfectly safe to consider that the heat losses on the inner or partition walls are insignificant. We can also generally disregard the ceiling loss, although in some cases it may be necessary to consider it. It is, however, seldom more than one-quarter that from the same area of exposed wall surface, since the difference of temperature between the room and the attic above is seldom more than one-third of that between the room and the exterior air and the ceiling can usually be regarded as giving an insignificant loss. It should be never neglected, however, unless this is known to be the fact.

Under usual circumstances, then, the total amount of heat which is to be supplied in heat units is 70 times the above quantity. The amount of heat which is supplied by 1 sq. ft. of radiating surface varies somewhat with conditions of structure and use, but does not differ greatly under ordinary conditions of pressure and temperature from 280 heat units per sq. ft. of steam heating surface and from 175 heat units per sq. ft of hot water heating surface. Dividing the formula given above after being multiplied by 70 by these latter numbers, we have as a result which is applicable to ordinary conditions and gives the amount of radiating surface to heat to 70° in zero weather.

For steam heating

$$R = \tfrac{1}{4} \left\{ \frac{n}{55} C + G + \tfrac{1}{4} W \right\}$$

For hot water heating

$$R = 0.4 \left\{ \frac{n}{55} C + G + \tfrac{1}{4} W \right\}$$

In the formulas given above R is the square feet of radiation, W the exposed wall surface, C the cubic contents, n the number of times the air in the room changes per hour, which varies from one to three, as explained.

Determining the Volume of Air Passing Through a Register per Minute.

This is the title of a paper read at the first session by Prof. J. H. Kinealy, of the Washington University, St. Louis. The following is an abstract:

The determination of the volume of air flowing through a register involves two separate and distinct problems, as follows:

1. The determination of the velocity of the air by the anemometer.
2. The determination of the fractional part of the area of the face of the register by which the velocity should be multiplied.

One method of determining the velocity of the air is to move an anemometer from side to side in zigzag lines over the face of the register and get the reading for an interval of one minute. The anemometer is usually held about ½-in. from the face of the register.

This method is the one usually adopted in tests, and if the velocity of the air is not great it will probably give quite correct results. But if the velocity of the air is great, especially when there are dead or negative areas on the register, great care is necessary in order to get correct results by this method. By dead areas are meant those small areas often found on the faces of the registers at which the anemometer will show no air coming out of the register nor any air entering; the velocity is zero. By negative areas are meant small areas often found on the faces of registers at which the anemometer shows that air is entering the register; the velocity is negative. Dead areas and negative areas are very common on registers of hot blast systems of heating; they are at the bottom of registers in walls, and in floor registers are at the end nearest the hollow of the bend of the air pipe.

Unless the dead areas and the negative areas are large or the anemometer is moved over them very slowly they will not be indicated by the anemometer when the velocity is determined by the first method, as, on account of the small amount of friction in the moving parts of the anemometer, it will continue to run while passing over these areas and will register positive velocity when it should register either no velocity or negative velocity.

After the average velocity has been determined the question that then arises is: What area should this velocity be multiplied by in order to obtain the volume of air flowing through the register per minute? It is evident that if this velocity were the velocity of the air as it passed through the openings in the face of the register, the proper area to use would be the actual area of the openings. The different streams of air from the openings mingle and mix to a great degree directly at the face of the register when the partitions between the openings are small, and as this mingling is accompanied by a reduction in the average velocity it is evident that if the mingling and mixing were perfect the proper area to use would be the area of the face of the register.

Let V be the volume in cubic feet of air passing through the register per minute; v the average velocity per minute as determined by the anemometer held about ½-in. from the face of the register; A the area of the face of the register in square feet; and x a factor to be determined. Then

$$V = xvA$$

If by a series of experiments we can determine V, v, and A for a given register we can then find $x = V \div vA$. Having once found x we can use it afterwards to find V when v and A are known. It is probable that x will vary slightly with v and with the ratio of the area of the opening in the register to the area of the face.

In order to determine x the writer made a number of experiments upon a floor register of a room on the first floor of one of the buildings of Washington University, St. Louis, Mo. The air was forced into the room by natural draft from a large indirect steam heating chamber in the basement. The experiments were made on different days, so as to get different values of v. The face of the register was about 13¾ by 21¼ ins., and its area was 292 sq. ins. The diameter of the pipe leading to the register was 14½ ins., and the area of the pipe was 165 sq. ins. The area of the openings in the face of the register was found to be 0.60 of the total area of the face of the register.

The volume V of air passing through the register was determined either by measuring the velocity of the air in the pipe leading to the register and multipiying this by the area of the pipe, or by measuring the velocity of the air passing through a box set on top of the register and multiplying this by the area of the box. The box was exactly the same size inside as the face of the register and 2 ft. high.

After all corrections had been made the values of x were found to be as follows for the different tests:

No. of test.	Value of x. V determined from pipe.	V determined from box.	Average velocity of air at face of register.
1	0.85	..	109
2	0.67	0.80	194
3	0.80	0.92	168
4	0.65	..	101
5	0.63	0.78	132
6	..	0.81	195
7	..	0.76	147

The writer does not think that much weight should be given to the values of x obtained by determining V from the readings of the anemometer when held in the pipe, as the velocity of the air was much greater near the center of the pipe than at the circumference, and it was almost impossible to move the anemometer about in the pipe so as to get an average value of the velocity of the air.

The average value of x when V was determined by the pipe is 0.72, and the average value when V was determined by the box is 0.81.

A short time after making these experiments the writer had an opportunity to make some others on a floor register whose face was 23¾ by 23¾ ins., through which air was forced by a fan. In these experiments the volume of air passing through the register was determined by placing on it an air tight box 23¾ by 23¾ ins. inside and 2 ft. high. The face of the register and the mouth of the box were each divided into 16 equal parts, and the average velocities of the air at the face of the register and at the mouth of the box were obtained by holding the anemometer in each small space for ten seconds and getting a reading. The value of x obtained from these experiments was 0.88.

I am inclined to think that x should be taken in all cases as about one-half the sum of one and the ratio obtained by dividing the actual area of the opening in the register by the area of the face of the register. As the actual openings in the ordinary registers are about 0.67 of the area of the face, this rule would give $x = \frac{1}{2}(1 + 0.67) = 0.83$; or, say 0.85.

This rule will be found to be accurate enough for all practical purposes as x will differ with the register, the way it is set, and the velocity of the air passing through it.

Separation of Oil and Grease from Exhaust Steam.

The paper with this title was read by Mr. Wm. J. Baldwin. We give an abstract below:

No doubt much of the oil that passes through the engine is simply held in mechanical suspension within the steam. It is more than probable, however, that a certain percentage of the oil, particularly with high pressure steam, is converted into a vapor and becomes thoroughly mixed with the steam and it will not separate until the steam's temperature has fallen below some certain point, which is difficult to fix and may vary with different oils.

With exhaust steam at or about 214 degrees F., some of the oil that originally entered the engine is carried away as a hot vapor, while the bulk or greater part of the oil is condensed or never was vaporized and passes out with the condensed water that the exhaust steam carries out of the cylinders and out of the pipes. The oil that is held in mechanical suspension within the steam is held in minute globules. The volatile oil within the steam is a vapor like the steam itself and is quite difficult to separate from the steam until the latter actually condenses.

In the separation of oil, therefore, from exhaust steam, we have two forms of it to contend with. The first, the globular form, which goes with the condensed water within the steam pipe, and the second, the vapor or volatile form, which is carried entirely by the steam.

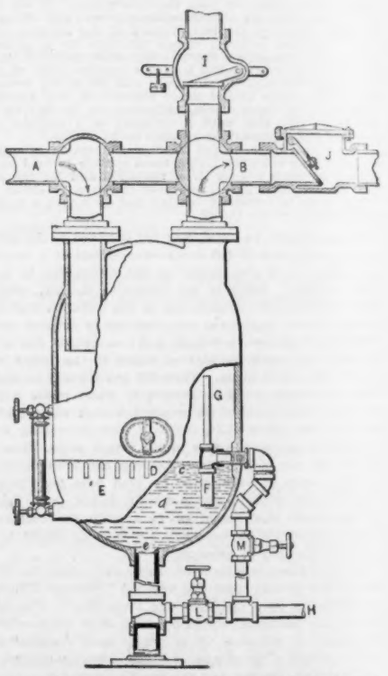
If in our endeavor to separate oil from exhaust steam we simply enlarge our exhaust pipe at some point until the steam as it passes through it has a velocity so slow that it is not capable of carrying its own condensed water with it, we have the first and one of the most important principles of a grease separator. When steam has not the power to carry its own water of condensation forward it has not the power to carry a liquid oil forward and will leave it in any suitable pocket below the line of a suitable enlargement in the exhaust pipe.

The enlargement must not only be great, but must be of some considerable length, and a change of direction in the current is also necessary. Deflectors in a small bulb or chamber simply add obstruction to the free discharge of the steam without appreciably diminishing its velocity, so that the steam, to escape around the deflectors is forced to impinge on them, and instead of a deflector being of any service as a hindrance to the passage of the oil it acts as an obstruction to the passage of the steam in such a manner that were oil fed down upon the face of the deflectors the steam would pick the oil up and carry it forward, instead of depositing its own oil in whole or in part as is now sometimes supposed.

About ten years ago I was compelled to look into this question very closely. A study of the question convinced me that there was no practical use in trying to separate oil from steam by what might be called mechanical means, such as straining or deflecting, or having so-called condensing or roughening surfaces within bulbs, unless, indeed, the bulbs had comparatively enormous diameters or bulk, so that the separation was by settlement, and it was found that when they had these great diameters it was not necessary to place any kind of obstruction device within the bulb except water to intercept the liquid oils. It was found that it was only necessary to change the direction of the steam by a simple elbow, so that the heavy particles of the water and oil would be carried, not horizontally but vertically downward, that they might be thrown against the surface of water held at the bottom of the bulb, where it was found that the oil and the water both remained.

It was also discovered that the lighter oils could also be caught and held within the apparatus by an arrangement of dams, though this was not anticipated at first.

The bulbs were arranged to maintain a constant depth of water at the bottom, which could be drawn off when desired for the purpose of carrying away the oil that accumulated. It was remarked that when steam and oil were projected on the surface of entirely clean water, there was an entire absence of oil on the surface of the water in the receiving tank, but that when oil accumulated on the surface of the water in the bulb a slight appearance of oil showed itself in the receiving tank. When watching the action of exhaust steam on the surface of the water it was noticed that at the moment when the puffs of the exhaust steam entered the bulb a clear space became visible on the surface of the water. The oil receded sidewise, exposing the surface of the water for the reception of the oil and condensed water that was coming with it, but that it instantly closed in between the puffs of the engine, exposing an oil surface again and thus alternating oil and water, until the oil accumulated to such an extent that the clear spot on the surface gradually became smaller and thus impaired the efficiency of the extractor, oil apparently not being as good a surface to deposit oil on as water. This led to the construction of oil dams within the bulb, shown at E in the illustration, the upper edge of which dams are



Apparatus for Separating Oil from Exhaust Steam. Designed by Wm. J. Baldwin, New York.

slightly above the water level of the apparatus, and their depth about 3 ins. with a high dam at D to prevent the return of the oil over the surface of the grating formed by the lower dams E.

The illustration shows the entire arrangement of the grease separator. Steam enters at A through a three-way cock, is cleansed of its oil and passes out again through B, either through the check valve J to the heating apparatus, or through the back-pressure valve I to the roof. The accumulated water within the body of the apparatus is carried away through the overflow F, which is made non-syphonable by the open pipe G, allowing but the excess of clean water to pass to the blow-off tank or sewer.

Occasionally the valve L is opened and the dirt, water, and oil blown out. The gradual overflow of clean water from F prevents the clogging of pipes or sewers which would be the case by the constant dripping of oil.